ACCELERATED ACTION DESIGN FOR THE ORIGINAL LANDFILL ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GEOTECHNICAL INVESTIGATION PHASE 3 STABILITY ANALYSIS TECHNICAL SUPPORT MEMORANDUM

Prepared for:
Kaiser-Hill Company, L.L.C.
Golden, Colorado

Prepared by:
Earth Tech, Inc.
Englewood, Colorado

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EXECUTIVE SUMARY

The purpose of this memorandum is to provide geotechnical input to support design of the accelerated action alternative at the Original Landfill (OLF) at the U.S. Department of Energy's Rocky Flats Environmental Technology Site (RFETS). The primary purpose and focus of the geotechnical investigation has been to develop geotechnical data and perform engineering analyses to a level adequate to support final design of the accelerated action. This has culminated with Phase 3 of the investigation, primarily consisting of the stability analysis of the OLF site with various accelerated action alternatives.

The Phase 2b field investigation work, conducted in June and July 2004, included both drilling and test pit exploration with associated sampling of subsurface materials for geotechnical laboratory testing. It was conducted for the primary purpose of obtaining additional data regarding the properties of the weaker colluvium/slide and weathered claystone bedrock materials underlying the site and controlling the landfill stability. This data, in combination with existing data from previous site investigation work, provides the basis for stability analyses (Phase 3) to support the final accelerated action design.

In support of the current project efforts, a comprehensive hydrogeologic model has been developed for Kaiser-Hill Company by Integrated Hydro Systems, LLC, based on the groundwater monitoring wells and geotechnical borings throughout the RFETS area. Input from this model was used in assigning groundwater levels used in the landfill slope stability analysis for specific geologic cross sections analyzed.

Existing data from previous site investigation work was used to support seismic stability evaluations. Both probabilistic and deterministic site-specific seismic shaking hazards were studied as part of the 1994 work by Risk Engineering. For this OLF Phase 3 evaluation, a value of 0.12g is established for the peak bedrock acceleration when proceeding with methods for the seismic slope stability analyses, and the mean magnitude earthquake of 5.9, for an RMA/Derby source, is established for use in deformation analyses. Detailed explanation of selected procedures and methodology for seismic stability evaluation, including deformation analysis, is provided in this report.

Significant laboratory strength testing of samples of the critical weaker colluvium and weathered claystone bedrock materials provided the primary basis for selecting parameters of these materials for use in the stability analysis. The approach used in selecting these critical materials strength parameters was to assign a lower bound value for all test data within the stress range involved in the analysis for various potential sliding surfaces. Drained strength, appropriate for use in long term static stability analysis, was assigned a design envelope with a 20 degree friction angle. Undrained strength, applied in pseudostatic seismic stability analysis, was assigned a design envelop with a 15 degree friction angle.

Static stability under long-term, steady state conditions, is required to achieve a minimum static safety factor of 1.5. This criteria is typical for earthfill embankments and is required by most agencies and design guidelines, and it is also used for solid waste landfills.

The minimum required pseudostatic safety factor is 1.0 using a seismic coefficient of one half the peak horizontal bedrock acceleration, or 0.06g for the case of the OLF. Seismically-induced permanent displacement shall be less than 12 inches, the generally accepted standard of practice for landfill covers, for the selected design earthquake event, should the pseudostatic safety factor be less than 1.0.

The results of computer-aided stability runs for the various combinations of three critical and representative geologic cross sections, established soil and bedrock density and strength parameters, three geometric conditions, circular arc and sliding block potential failure mechanism searches, and two different groundwater conditions, for both static and seismic conditions, are provided on key summary figures, and show:

- All cases analyzed for existing topographic conditions have safety factor results equal to or less than 1.5 for static analysis and less than 1.0 for pseudostatic analysis.

- All cases analyzed for an overall 18 percent regrade condition have safety factor results ranging from 1.5 to 1.7 for static analysis and less than 1.0 for pseudostatic analysis.
- All cases analyzed for an overall 18 percent regrade condition have estimated maximum seismically induced permanent displacement results ranging from 5 to 10 inches.
- A surficial stability check of anticipated cover materials indicates that static and pseudostatic safety factors for saturated slope conditions are acceptable.

Some final observations and conclusions regarding aspects of this investigation that are considered conservative to the results of the stability analysis and design of the accelerated action are as follows:

- Strength parameters used for the critical materials controlling stability results are conservative lower bound values of all test data within the anticipated stress range.
- The highest groundwater condition analyzed in combination with seismic loading is quite conservative, as the likelihood of both these conditions occurring simultaneously is low.
- The overall 18 percent regrade design slope is conceptual in nature. Further refinement of this regraded slope with further consideration given to surface water management, groundwater elevations, and bedrock elevations will improve stability issues.

As a result of the data presented and reviewed in this report, the results of static and seismic stability analyses, and past design experience, it is concluded that no stability enhancement beyond slope regrading is required to meet established design criteria for the accelerated action at the OLF.

1.0 INTRODUCTION

The following sections present information regarding the purpose of this memorandum and the supporting field investigation and engineering analysis. This section also presents site background information and details past investigation efforts.

1.1 PURPOSE

The purpose of this memorandum is to provide geotechnical input to support design of the accelerated action alternative at the Original Landfill (OLF) at the U.S. Department of Energy's Rocky Flats Environmental Technology Site (RFETS).

This document is prepared for Kaiser-Hill Company, LLC, and summarizes the results of Earth Tech Phase 2 and Phase 3 geotechnical investigation activities for accelerated action design. Phase 1 and preliminary Phase 2 work was documented in memoranda dated April 26 and July 27, 2004, respectively. This submittal includes supplementary field exploration and laboratory testing data (Phase 2 investigation), as well as geotechnical engineering analyses and conclusions (Phase 3 investigation), in support of the accelerated action design.

The primary purpose and focus of the geotechnical investigation has been to develop geotechnical data and perform engineering analyses to a level adequate to support final design of the accelerated action. This has culminated with Phase 3 of the investigation, primarily consisting of the stability analysis of the OLF site with various accelerated action alternatives.

1.2 SITE DESCRIPTION AND PROJECT ALTERNATIVES

The OLF site is located south of RFETS Buildings 440 and 460, along the north hillside of a ravine in the Woman Creek drainage area, extending from approximate Elevation 6,040 feet at the top to Elevation 5,950 feet at its base. The OLF site footprint has a maximum length along the east-west direction of approximately 1,700 feet, and approximately 500 feet in the north-south direction, with an approximate area on the order of 20 acres. Existing slope gradients range from approximately flatter than 6 to 1 (horizontal to vertical) to 2 to 1, with a total slope height from the top of the hillside to the Woman Creek drainage of about 90 feet.

Relative to the specific OLF area of the RFETS, and the associated geotechnical investigation directed toward the Phase 3 stability analysis of the site, aspects of the accelerated action project alternatives involving the landfill area slope and conditions controlling its stability are as follows:

- No action for the landfill, only industrial area regrading (existing topographic conditions for stability analysis).
- Overall 18 percent regraded landfill slope with 2-foot soil cover and drainage improvements (18 percent regrade condition for stability evaluation).
- Landfill slope regrade with buttress at toe for stability enhancement (18 percent regrade with buttress condition for stability evaluation).

A fourth alternative adds an uphill groundwater cutoff wall. Since groundwater modeling has indicated that a cutoff would have relatively minor impact in lowering groundwater levels in the landfill slope and enhancing stability, this was not translated to an additional alternative for stability evaluation.

1.3 SUPPORTING INVESTIGATIONS

The relevant geotechnical and geologic investigations, both previous and current, that were conducted at or adjacent to the RFETS OLF and support this memorandum, are as follows:

- Metcalf & Eddy (M&E) 1995 exploration of the OLF, which reviewed historic air photographs of fill placement (early 1950s to late 1980s), and included drilling and geologic logging of 20 exploratory borings and collecting suitable soil samples for conducting geotechnical laboratory testing, and presenting findings for evaluating causes and extent of landsliding at the site. Depth of borings typically ranged from approximately 30 feet (namely, a few feet into the unweathered bedrock formation) to 150 feet.
- Earth Tech 2002 exploration at the top of the OLF slope into the Rocky Flats Alluvium, including 13 exploratory borings located approximately parallel and at a distance of nearly 100 feet north of the OLF, on the alignment of a potential groundwater diversion system. Exploration included both auger and rock core drilling to depths of 50 to 80 feet and soil/rock sampling, and classification, index, and engineering properties testing in the laboratory.
- Earth Tech 2004 supplemental exploration of the OLF, in support of the accelerated action design and focused on investigating the weaker subsurface materials controlling

landfill stability (Phase 2b investigation). Exploration included drilling and geologic logging of 11 borings to depths of 42 feet, and excavating and logging 6 test pits.

- Geomatrix Consultants/Risk Engineering 1994 evaluation of subsurface soils conditions at the top of the Rocky Flats Alluvium, including review and summary of available geotechnical data at 60 locations, including a total of approximately 150 borings within the RFETS, including 22 previous soil investigation reports for individual buildings, six geophysical reports, four seismic hazard/risk and geologic investigation reports, and one groundwater monitoring report.

- Risk Engineering 1995 comprehensive evaluation of earthquake sources in the vicinity of the RFETS. Work was performed by a team of consultants and members of academia lead by Risk Engineering (Geomatrix Consultants, EQE International [Dr. K.W. Campbell], University of Utah [Dr. W.J. Arabasz], Stanford University [Dr. A. Cornell], Dr. G.A. Bollinger, 1994), including a state-of-the-art seismic hazard study. Previous geologic and seismicity studies had been conducted by Blume (1974), TERA (1976), Dames and Moore (1981) and Ebasco (1992).

2.0 FIELD AND LABORATORY INVESTIGATIONS

The most recent geotechnical field and laboratory investigation programs undertaken at the original landfill were for the primary purpose of obtaining additional data regarding the properties of the weaker colluvium/slide and weathered claystone bedrock materials underlying the site and controlling the landfill stability. This data, in combination with existing data from previous site investigation work, provides the basis for stability analyses to support the final design of the accelerated action. The investigation activities were conducted in accordance with the Phase 2b Field and Laboratory Investigation Plan dated June 2004.

2.1 EXPLORATION BOREHOLES AND TEST PITS

The Phase 2b field investigation work, conducted in June and July 2004, included both drilling and test pit exploration with associated sampling of subsurface materials for geotechnical laboratory testing. A focused drilling program was directed toward undisturbed sampling of the weaker subsurface materials susceptible to, or currently involved in, instability, including primarily the colluvium/slide and weathered claystone bedrock materials. Limited test pitting by backhoe excavation at strategic locations was directed toward obtaining a visual look at the colluvium/slide interface with the weathered claystone bedrock surface, and sampling of these weaker subsurface materials as appropriate.

Exploration and sampling locations are shown on Figure 1. Borehole and test pit logs are provided in Appendix A.

Listed below is a summary of the drilling and test pit work:

- Drilling and test pit exploration activities occurred between June 18 and July 14, 2004.
- Exploration boreholes, including some adjacent offset holes for additional sampling or due to difficult drilling conditions, were drilled at or near the 10 locations identified in the investigation work plan (Figure 1). One additional hole was drilled in the vicinity of Test Pit No. TP-5.
- Borehole depths ranged from 14 to 42 feet.
- All boreholes were advanced through the weathered claystone bedrock materials and terminated in relatively unweathered claystone bedrock.

- Undisturbed samples were retrieved during the drilling operations from the various material types encountered, focusing on the colluvium and weathered claystone bedrock materials.

- Continuous dry core was retrieved from all boreholes and saved in core boxes for visual observation.

- Exploration test pits were excavated at or near the 6 locations identified in the investigation work plan (Figure 1).

- Test pits typically ranged from 10 to 15 feet in depth.

- The weathered claystone bedrock material was intercepted in 5 of the 6 test pits, and sampled in 4 of the test pits (Test Pit Nos. 1, 3, 4, and 6).

Field exploration findings are summarized as follows:

- No significant unanticipated conditions were encountered during the Phase 2b field investigation work, relative to conditions anticipated from familiarity with previous site exploration data.

- The field exploration encountered all material types anticipated, including fill, colluvium, valley fill alluvium, severely weathered claystone, moderately weathered claystone, and unweathered claystone. These material types and depths at which they were encountered match up well with the findings from previous site exploration.

- The most critical colluvium/slide and severely weathered claystone bedrock materials were encountered at most of the exploration locations.

- The most unanticipated finding was localized soft, fine-grained alluvial material encountered at one exploration location below the base of the landfill, at Borehole No. BH-9.

2.2 GEOTECHNICAL LABORATORY TESTING

Review of the undisturbed samples and core retrieved during the Phase 2b field exploration work, and formulation of the geotechnical laboratory testing program, occurred between July 12 and 15, 2004. This process included detailed evaluation and selection of samples and procedures for the testing program, including careful review of field data and logs, and visual review of the drilling core and undisturbed samples retrieved for potential testing. This activity involved discussion between the geotechnical engineer and field geologist, and a meeting and review of representative samples for testing between the geotechnical engineer and laboratory testing staff.

The primary focus of the Phase 2b laboratory testing program was the determination of strength of the weaker colluvium/slide and weathered claystone bedrock materials underlying the site and controlling the landfill stability. A range of index properties tests was also performed on selected samples for classification, characterization, and confirmation of field logging. Based on the sample review and testing program formulation process described above, the most critical and also representative samples available were selected for testing.

Listed below are the test procedures and numbers of tests performed for the Phase 2b laboratory investigation:

- Moisture Content (ASTM D2216) - 8 (additional tests part of other engineering properties tests)
- Density (ASTM D2937) - 8 (additional tests part of other engineering properties tests)
- Particle Size Analysis (ASTM D422) - 23
- Atterberg Limits (ASTM D4318) - 17
- Consolidation (ASTM D2435) - 4
- Direct Shear (ASTM D3080) - 27 points
- Consolidated Undrained Triaxial Strength - ICU (ASTM D4767) - 33 points

For the direct shear strength tests specified, 15 points were run on severely weathered claystone materials, 6 points were run on moderately weathered claystone materials, and 6 points were run on colluvium materials. For the triaxial strength tests specified, 18 points were run on severely weathered claystone materials, 6 points were run on moderately weathered claystone materials, 6 points were run on colluvium materials, and 3 points were run on fine grained alluvium materials.

The laboratory testing program described above was completed in September 2004. All Phase 2b geotechnical laboratory test data is provided in a separate volume to this memorandum, referenced in Appendix B.

3.0 SITE CONDITIONS

The following section details regional geologic and seismic conditions, site geologic conditions, site groundwater conditions, landsliding issues, and anticipated seismic shaking. Information from each of these conditions is incorporated into subsequent stability analyses.

3.1 REGIONAL GEOLOGIC AND SEISMIC SETTING

The regional geologic and seismic setting surrounding the OLF are presented in the following section.

3.1.1 Geologic Setting

The OLF is located on the south side of the RFETS, which is in turn located on the western edge of the Colorado Piedmont section of the Great Plains Physiographic Province (Hunt, 1974). The piedmont slopes eastward and is incised by drainages flowing from the Front Range into the Great Plains. The Rocky Flats was formed by erosion of Cretaceous-age (Arapahoe and Laramie) bedrock formations, and subsequent deposition of the Pleistocene Rocky Flats Alluvium atop the resulting eroded surface. The claystone bedrock slopes below the rocky surface were exposed by continued stream erosion through the pediment. Landsliding on these slopes probably commenced at about the middle Pleistocene, shortly after the slopes were initially exposed (Shroba and Carrara, 1994). A more detailed description of the regional geologic history and setting is presented in the Geologic Characterization Report for RFETS (EG&G, 1995).

As described in previous RFETS geologic and seismologic reports (Blume, 1974; Ebasco, 1992; Risk Engineering/Geomatrix, 1994), in general, the lithologic column includes the following:

- Rocky Flats Alluvium, consisting of fan deposits of early Pleistocene age (1 to 2.5 million years) is derived from the Front Range. These deposits are predominantly of bouldery and cobbley, silty, clayey, and sandy gravel nature, ranging in thickness from less than 1 foot to over 100 feet, and averaging 10 feet. Rocky Flats Alluvium is underlain by sedimentary bedrock.

- Sedimentary Bedrock of Cretaceous age (65 to 135 million years) of the Arapahoe Formation, Laramie Formation, and Fox Hill Sandstone, and Pierre Shale, in descending order, which at the RFETS dips generally 1 to 5 degrees to the east, with local variations of up to 20 degrees. The uppermost unit, the Arapahoe Formation is approximately 120 feet thick and consists of claystone with interbedded sandstone and siltstone. The

Laramie Formation consists of clayey shale, sandy shale and claystone, and is approximately 600 to 800 feet thick. The Fox Hill Sandstone is approximately 100 feet thick. The Pierre Shale is approximately 8,000 feet thick.

- Crystalline Bedrock, underlying sedimentary units at the site, at a depth on the order of 10,000 to 13,000 feet.

3.1.2 Seismic Sources and Historic Seismicity

A state-of-the-art evaluation of earthquake sources in the vicinity of the RFETS was performed by a team of consultants and members of academia lead by Risk Engineering (1994), and some of their findings and conclusions are summarized below:

Primary seismic sources that were identified (Risk Engineering Table 2-1 and Figure 2-3) include the following faults, all located within 25 kilometers of the site:

- Golden-Boulder Fault, maximum magnitude 7 to 7-1/2,
- Valmont Fault, magnitude 5-3/4 to 6-3/4
- Walnut Creek Fault, magnitude 5-3/4 to 6-3/4 and
- Rock Creek Fault, magnitude 5-3/4 to 6-3/4

Five areal seismic sources were identified (Risk Engineering Figure 2-2), as follows:

- Denver Basin – Regional Source I, with maximum magnitudes from 5-1/2 to 7 or 5-1/2 to 6, depending whether or not the 1882 Colorado earthquake occurred within this regional source

- Eastern Rocky Mountains – Regional Source II with maximum magnitudes from 5-1/2 to 7 or 5-1/2 to 6-1/2, depending whether or not the 1882 Colorado earthquake occurred within this regional source

- Western Colorado/Rio Grande Rift Source – Regional Source III with maximum magnitudes from 6-1/2 to.7-1/2

- Great Plain Sources – Regional Sources IV and V, with maximum magnitudes from 5-1/2 to 6

The areal sources represent the occurrence of earthquakes which could not be associated with a specific fault.

An additional seismic source was associated with deep-well waste fluid injection, as follows:

- Rocky Mountain Arsenal (RMA)/Derby located approximately 15 to 25 kilometers east of the Rocky Flats, which could generate maximum magnitude earthquakes of 5-1/2 to 7.

The 1994 Risk Engineering study included a comprehensive review of historical records, to provide a data base for statistical evaluation, including pre-instrumental shocks in Colorado, such as the Maximum Historic 1882 Colorado earthquake with an assigned, estimated moment magnitude of 6.4 ± 0.3. However, there is uncertainty as to the source location of this historic event.

The translation of this historic seismic data to selection of a design seismic event is discussed later in this Section 3.

3.2 SITE GEOLOGIC CONDITIONS

As described in the 1995 M&E report, the Original Landfill is located in the Buffer Zone to the south of Building 440 and 460, on the south facing slope, between the edge of the Rocky Flats alluvial terrace and Woman Creek. It is reported, based on review of historic air photographs, that placement of fill commenced during the early 1950s and continued at least into the late 1980s, with much of the waste fill apparently dumped off the edge of the flat alluvial terrace, onto the slope and intermixed with native Rocky Flats alluvium and colluvial materials.

Areal distribution of the surficial geologic units is shown on Figure 2 of the 1995 M&E geotechnical/geologic investigation report, which is reproduced in Appendix C of this memorandum (Figure C1). In addition, Figures 4 through 10 of the M&E report include geologic cross sections A-A' through G-G' showing interpreted surface and subsurface soil and bedrock conditions, which are also included in Appendix C of this memorandum (Figure C2 through C8). Results of the supplementary (Phase 2b) geotechnical field exploration at the site appear to generally confirm subsurface soil conditions depicted by the 1995 M&E report. Phase 2b exploratory borings and test pits (included in Appendix A of this memorandum) were added to the 1995 M&E cross sections (Appendix C).

A brief description of the site geologic units is as follows:

Waste Fill: Waste fill predominantly consists of sandy and clayey gravel and cobbles (GC) derived from colluvial and Rocky Flats alluvial materials that were mixed with varying concentrations of waste from historical RFETS production activities. It was estimated that the ratio of volume of soils to waste is on the order of 2 to 1, or about 67 percent soil to 33 percent waste. The observed waste included sheet metal, wood, broken glass, plastic, rubber, metal shavings, glass, solid blocks of graphite and graphite sand, concrete, asphalt and portions of 55-gallon steel drums. The fill generally varies from loose to medium dense, generally dry to moist, although occasionally wet when underlain by an impervious material. Waste fill ranged in thickness at boring locations from approximately 2 to 11 feet, although it may locally be as thick as 15 to 20 feet, as shown on interpreted geologic sections. Further, it is anticipated that after potential slope regrading and capping of the original landfill site, some sections may locally include on the order of 25 feet of waste and other fill.

Clean Fill: Clean fill soils were locally found under the road located immediately south of the south interceptor ditch (SID), and as relatively thin cover (generally less than 10 feet in thickness) related to the construction of the buried outfall pipe over the northeastern portion of the OLF, as shown on cross section D-D', E-E', and G-G' (Appendix C).

Colluvium (Qc): These deposits vary from sandy, clayey gravel and cobbles (derived from the Rocky Flats Alluvium) to sandy clay (GC to CL), and are located on slope areas below the Rocky Flats Alluvium. Colluvial materials have reportedly (M&E, 1995) been mobilized by several instances of landsliding, and apparently have slid atop the weathered bedrock, as well as have been incorporated within deeper seated slides.

The coarser-grained colluvium is generally medium dense, while the finer-grained colluvium varies from stiff to medium stiff, although looser, softer and wet colluvium was occasionally encountered during the 1995 M&E exploration. Colluvium ranged in thickness at boring locations from approximately 1 to 13 feet, although it may locally be as thick as 15 feet or slightly thicker, as shown on interpreted geologic section G-G' (Appendix C).

Rocky Flats Alluvium (Qrf): These pediment/fan deposits which comprise the flat alluvial surface of Rocky Flats were generally dense, sandy, clayey gravel with cobbles (GP, GC), with occasional interbedded layers of stiff to hard clays and sandy clays (CL, CH) as well as fine, medium dense to very dense clean and clayey sands (SP, SC). Alluvial materials have reportedly (M&E, 1995) ranged in thickness at boring locations at the top of the slope, from approximately 30 to nearly 50 feet, and generally above Elevation 5,995 feet to 6,010 feet, as shown on interpreted geologic sections A-A' through F-F' (Appendix C).

Geomatrix (1994) conducted a fairly comprehensive characterization of this alluvium with the purpose of evaluating its susceptibility to liquefaction (if any) based on numerous available geotechnical studies previously conducted at the Rocky Flats (namely, field exploration and laboratory test data). Of the 327 soil samples and penetration resistance measurements, roughly speaking one third corresponded to clayey materials (CL), one third in sandy materials (SC, SM), and the other third in gravelly materials (GC, GM). It was concluded that the clayey materials were generally very stiff, and that the sandy and gravelly materials were medium dense to very dense. Geomatrix also reported average groundwater levels within the Rocky Flats Alluvium of 5 to 10 feet below ground surface. Woodward-Clyde Consultants (WCC, 1986) similarly reported groundwater depths of 7 to 15 feet in 5 of 10 exploratory borings. Groundwater within the Rocky Flats Alluvium is interpreted to be perched within the varied and individual layers of more pervious sands or gravel above clay layers or the claystone bedrock.

<u>Valley Fill Alluvium (Qal)</u>: These deposits encountered along Woman Creek vary from medium dense to dense, sandy, silty-clayey gravel with cobbles (GP, GM-GC). Alluvial materials have reportedly (M&E, 1995) ranged in thickness at boring locations at the toe of the slope, from approximately 5 to 7 feet, as shown on interpreted geologic sections A-A' through F-F' (Appendix C). Groundwater in alluvium was found as shallow as 2 feet.

<u>Claystone</u>: The bedrock underlying the OLF predominantly consists of Laramie Formation claystone, with subordinate beds of siltstone and sandstone. Under the landfill, this formation is relatively flat-lying (i.e., near horizontally bedded), and for engineering property evaluation purposes it was characterized, depending on the degree of weathering, as "severely weathered" (sw), "moderately weathered" (mw), or "unweathered" (uw), as part the 1995 M&E investigation. This characterization was adopted by this geotechnical investigation and is summarized as follows:

- Severely Weathered Claystone (CSsw), which represents bedrock that is weathered to the extent that the original rock texture and structure (e.g., bedding, fracturing) is no longer recognizable. This material generally consists of moist to wet, stiff to very stiff (occasionally medium stiff), lean to fat clay, and ranged in thickness at exploration locations from less than 0.5 to 4 feet.

- Moderately Weathered Claystone (CSmw), which represents bedrock that ranges from highly weathered (but showing some discernable structure with typical iron oxide staining) to slightly weathered (nearly fresh, but showing some occasional iron staining). Moderately weathered claystone is usually friable (locally plastic) and soft, typically damp to moist, and of hard consistency, and moderately to highly plastic. Bedding and fracturing (jointing) ranges from massive (without recognizable bedding structure, unfractured) to thinly laminated (parallel bedding surfaces spaced at less than about 0.1 inch) and/or intensely fractured, interbedded with thin laminae of silt and very fine sand. The thickness of the moderately weathered claystone ranged from approximately 2 to 23 feet.

- Unweathered Claystone (CSuw), which represents bedrock that completely lacks iron staining, and represents rock that has little or no hydraulic connection with surficial water. (i.e., water in the upper hydrostratigraphic unit). The strength, hardness, and fracturing characteristics of the unweathered claystone were generally comparable to those of the moderately weathered claystone, although somewhat drier (ranging from damp to dry) and harder to drill. Depth to the top of unweathered claystone was interpreted to range from a minimum of approximately 15 to 20 feet at the toe of the slope to about 50 feet under the Rocky Flats Alluvium, as shown on M&E Sections A-A' through F-F' (Appendix C).

3.3 GROUNDWATER CONDITIONS

The 1995 M&E report concluded that, based on examination of 62 shallow groundwater monitoring wells and geotechnical borings, most groundwater in the study area appears to be perched atop bedrock, within the deeper portions of colluvium and fill overlying bedrock. The source of most groundwater was interpreted to be within the lower portion of the Rocky Flats Alluvium, penetrating the colluvium and/or fill surficial deposits. Based on the previous groundwater level measurements, the shallow groundwater appeared to concentrate in the lower portion of the surficial deposits, and flow downslope near parallel to the ground and bedrock surfaces, as shown on M&E geologic cross sections (Appendix C).

More recently, in support of the current project efforts, a comprehensive hydrogeologic model has been developed for Kaiser-Hill Company by Integrated Hydro Systems, LLC, based on the groundwater monitoring wells and geotechnical borings throughout the RFETS area. The results of this hydrogeologic model are the subject of a separate technical support memorandum. Input from the model used in assigning groundwater levels used in the landfill slope stability analysis, for the geologic cross sections analyzed, is included in Appendix D of this memorandum.

In general, groundwater was found to approximately follow the shape of the top of the weathered claystone bedrock profile and to be located within the lower portion of colluvium and fill surficial deposits. When compared to the existing landfill ground surface slope, the groundwater surface was found to locally reach depths of less than 10 feet.

When compared to the alternative regraded slope configuration, modeled groundwater depths for a typical year climate condition are generally 5 to 10 feet below regraded ground surface or greater, with localized areas less than 5 feet. For a wet season climate condition, modeled groundwater was observed to rise. The modeled groundwater elevations used in the slope stability evaluation were those for a mean annual wet-year groundwater level, and a maximum annual wet-year groundwater level. The modeled groundwater profiles representing these two conditions, for the three cross sections evaluated (cross sections B, C and D), are shown in Appendix D.

As summarized previously, Geomatrix Consultants (1994) also reported average groundwater levels within the Rocky Flats Alluvium of 5 to 10 feet below ground surface. Woodward-Clyde Consultants (WCC, 1986) similarly reported groundwater depths of 7 to 15 feet in 5 of 10 exploratory borings. Groundwater within the Rocky Flats Alluvium is interpreted to be perched within the varied and individual layers of more pervious sands or gravel above clay layers or the claystone bedrock.

3.4 LANDSLIDING

The project site area is generally shown as having some potential for landsliding based on preliminary U.S. Geological Survey maps of landslide deposits of the Denver Quadrangle and the Louisville Quadrangle compiled by Colton and Holligan (1975 and 1977, respectively). Colton and Holligan define landslide deposits as masses of earth and rock that have moved downslope as earthflows and slumps that have formed along gravel-capped mesas where springs and seeps have saturated the underlying shaley or clayey parts of the Pierre Shale, the Laramie

Formation, and the Arapahoe Formation (all Upper Cretaceous). In addition, Colton and Holligan also define areas susceptible to landsliding as general slopes steeper than 10 percent, because slopes of only a few degrees on saturated shale have failed. Conversely, slopes steeper than 10 percent that are underlain by sandstone units of the Fox Hill Sandstone (Upper Cretaceous) and the lower part of the Laramie Formation are generally not susceptible to large slope failures.

Landsliding of these slopes probably commenced at about the middle Pleistocene, shortly after the slopes were initially exposed (Shroba and Carrara, 1994). The 1995 M&E geotechnical/geologic investigation concentrated in understanding the potential for landsliding at the site, and included a detailed review of available geologic data and airphoto interpretation, geologic mapping, and exploratory drilling. The geologic map and cross sections developed by this previous investigation, depicting the evidence of previous landsliding, are reproduced in Appendix C of this technical memorandum for reference.

It should also be noted that water from the RFETS facilities was periodically drained on to the landfill area slopes by a ditch (covered prior to 1983) and an outfall pipe constructed in 1983, which likely caused episodes of sliding from 1983 to 1986, after which the outfall pipe was replaced by a buried outfall pipe that drains southeast into the south interceptor ditch (SID).

3.5 SEISMIC SHAKING

Both probabilistic and deterministic site specific seismic shaking hazards were studied as part of the 1994 work by Risk Engineering. The probabilistic approach was used in subsequent calculations, according to federal regulation requirements for landfill cover design, supplemented with deterministic analyses for computation of seismically-induced permanent displacements of slopes, as part of the stability evaluation for this investigation.

Probabilistic analyses integrate overall earthquake magnitudes and locations to calculate a combined frequency of exceeding various ground motion levels. Conversely, deterministic analyses are based on the concept of a single design event. The dominant earthquake may be chosen as the mean magnitude and distance that caused a ground motion level to be exceeded at the chosen return period.

The dominant seismic source used for deterministic seismic hazard evaluations was a recognizable seismic source that generally dominates earthquake hazard at the RFETS, namely the RMA/Derby, with a mean magnitude of 5.9 and distance of 27 kilometers, resulting in a peak horizontal acceleration in rock of approximately 0.083g (as summarized in Risk Engineering Tables J-3, J-4 and Figures J-15 through J-18). This event was established for permanent slope deformation analysis evaluations for this OLF Phase 3 evaluation.

Further, these analyses were performed for both "rock" and "soil" site conditions. A firm rock profile is defined as corresponding to an average shear wave velocity in the top 100 feet of at least 2,500 feet per second. Peak horizontal acceleration in rock evaluated by Risk Engineering as part of the seismic shaking hazard study for an earthquake event having a median value with 2 percent probability of exceedance in 50 years, which is the regulatory standard, was calculated to be slightly greater than 0.10g. U.S. Geologic Survey maps show a peak horizontal bedrock acceleration value of approximately 0.12g, for the same probability of exceedance.

The project site is in a zone of fairly low potential for major seismic activity. However, the appropriate seismic potential and shaking hazards need to be recognized and accounted for in the accelerated action design. The above seismic shaking evaluation methods, including the selected seismic shaking input criteria, is detailed in subsequent discussions related to the landfill slope potential deformation evaluation, as part of the overall stability analysis.

For this OLF Phase 3 evaluation, a value of 0.12g is established for the peak bedrock acceleration when proceeding with methods for the seismic slope stability analyses, and a design earthquake with a mean magnitude of 5.9 is established for use in the deformation analyses. Further details related to the seismic stability and deformation analyses are described in Section 5 of this report.

4.0 GEOTECHNICAL MATERIAL PROPERTIES

This section details the material properties for the soil and bedrock materials evaluated in the geotechnical evaluation. It includes material characteristics of waste and other fill, Rocky Flats, Alluvium, colluvium and weathered claystone, and unweathered claystone. This section also includes discussions on critical material strengths and seismic strength considerations.

4.1 GENERAL MATERIALS CHARACTERIZATION

The evaluation of the various geologic units made during field investigation, including air photograph interpretation, geologic mapping, logging of exploratory boreholes and test pits, penetration testing, coring, and sampling, was supplemented with geotechnical laboratory testing, including classification, index, and engineering properties testing on selected soil and weathered bedrock samples. Material property profiles versus depth, based on data from the 2004 and 2002 Earth Tech investigations as well as the 1995 M&E investigation, were utilized for general characterization and evaluation of material properties variation. Observations from this data evaluation are discussed in the following sections for general materials characterization.

4.1.1 Waste and Other Fill

Waste fill materials are known to include significant amounts of Rocky Flats Alluvium (possibly as much as 67 percent), construction debris, and other materials. They exhibit blow counts on the order 10 to more than 50 blows per foot (bpf), but most commonly in the range of 10 to 35, and are therefore considered loose to medium dense. Clean fill (used for road and outfall pipe backfill) was not specifically targeted during this investigation, but it is anticipated to range medium dense to very dense.

4.1.2 Rocky Flats Alluvium

Geomatrix Consultants (1994) discussed the clayey, sandy, and gravelly/cobbley nature of this alluvium. Blow counts in the clayey materials average 28 $\pm$ 14 bpf, although several blow counts were cut off at 30 to 50 blows, and, therefore, the reported average blow count value is considered conservative. Blow counts within the sandy materials averaged 38 $\pm$ 14 bpf, and, similarly cut off at 50 blows, the reported average blow count value is considered conservative. Blow counts within the gravelly materials averaged 41 $\pm$ 13 bpf and, similarly cut off at 50 blows, the reported average blow count value is considered conservative. Based on Geomatrix Consultants evaluation of soil penetration resistance, it is concluded that the clayey (CL, CH) materials are generally very stiff, and that the sandy (SM, SC) and gravelly (GP, GM, GC) materials are medium dense to very dense.

4.1.3 Colluvium and Weathered Claystone

These materials exhibit Plastic Limit (PL) values ranging from approximately 15 to 20 and Liquid Limit (LL) values ranging from approximately 36 to nearly 80, with resulting Plasticity Index (PI) values ranging from roughly 20 to nearly 60. These soils typically classify as fat clay (CH) and less frequently as lean clay (CL), and in the case of the colluvium, they contain sand and gravel in various fractions. The coarse-grained fraction (sands, gravels, and cobbles), are usually less than 20 percent, but occasionally as high as 60 percent.

The bottom of these materials is highlighted by a significant contrast of soil penetration resistance between surficial materials (waste, clean fill, colluvium, and severely weathered claystone) versus the moderately weathered to unweathered claystone bedrock formation, indicating a significant improvement of engineering properties (compressive and shear strength increase, and reduction in compressibility), for materials encountered below the more highly weathered bedrock material. This depth is variable, but is typically about 30 to 35 feet below the existing slope ground surface.

In-place moisture contents and dry unit weights in colluvium were found to typically vary from 15 to 35 percent and 100 $\pm$ 10 pounds per cubic foot (pcf), respectively. When comparing in-place moisture contents with PL and LL values, it is apparent that in-place moisture contents are somewhat higher than the PL, with liquidity indices on the order of 0 to 0.3, suggesting a slightly overconsolidated colluvial material (possibly the result of clay desiccation). Unconfined compressive strength in the colluvium usually varied from approximately 1 to 2.5 tons per square foot (tsf), although values as low as 0.7 tsf and higher than 4.5 tsf were occasionally measured.

Four consolidation tests performed on severely weathered claystone (CSsw) suggested over consolidation ratios approximately in the range of 1.5 to 3.5.

4.1.4 Unweathered Claystone

In-place moisture contents were found to typically range from 5 to 25 percent (or about 10 percent less than overlying materials). When comparing in-place moisture contents with PL and LL values (essentially in the same general range of those for the overlying colluvium and weathered claystone), it is apparent that in-place moisture contents are usually less than, or about equal to PL values. Consequently, liquidity indices were commonly less than zero, indicating their overconsolidated nature (namely, stronger and less compressible engineering characteristics). Consistent with the latter comparison, unconfined compressive strength in moderately weathered to unweathered claystone usually varied from approximately 10 to 25 tsf, although values as low as 5 tsf and higher than 35 tsf were occasionally reported.

4.2 CRITICAL MATERIAL STRENGTH

As discussed previously, the primary focus of the most recent Phase 2b field and laboratory investigations has been to obtain additional data regarding the properties, primarily engineering strength, of the weaker colluvium/slide and weathered claystone bedrock materials underlying the OLF site and controlling the landfill stability. The numbers and types of strength tests performed, as well as on which type of material the various tests were conducted, was summarized in Section 2.2. The results of all the strength testing performed for the Phase 2b investigation are provided and summarized on Figures 2 through 6. For each type of strength test result, the data for all tests on colluvium/slide and weathered claystone materials is compiled on one figure, for summarization and comparison purposes.

Figures 2 and 3 present triaxial shear test, drained strength test data, which is appropriate for use in long term static stability analysis. Figures 5 and 6 present triaxial shear test, undrained strength test data, from the same strength tests on the various samples listed, which is appropriate for use in short-term loading conditions, such as seismic shaking. Figure 4 presents both peak and residual strength test data from direct shear testing, according to the method providing primarily drained strength results.

The difference between the two triaxial drained strength test data summaries, Figures 2 and 3, and between the two triaxial undrained strength test data summaries, Figures 5 and 6, is the presentation of the data according to a couple of different, commonly selected sample failure criteria. Figures 2 and 5 present strength data based on a maximum principal stress ratio sample failure criteria. Figures 3 and 6 present strength data based on a 5 percent strain sample failure criteria. The summaries indicate that the results are very much the same for the two different criteria.

A lower bound strength envelope for all Phase 2b investigation tested colluvium/slide and weathered claystone critical materials is superimposed on the test data summaries for both drained, effective stress strength (Figures 2, 3, and 4) and undrained, total stress strength (Figures 5 and 6), respectively.

When reviewing Figures 2, 3, 5, and 6, it can be seen that the laboratory samples demonstrated a significant cohesion value that contributes to the overall material strength. Figure 2 shows cohesion ranging from 200 pounds/square foot (psf) to 600 psf with an average of 410 psf; Figure 3 shows 150 psf to 700 psf with an average of 425 psf; Figure 5 shows 150 psf to 600 psf with an average of 420 psf; and Figure 6 shows 100 psf to 800 psf with an average of 510 psf. The lower bound strength envelope, which is superimposed on each figure, as a conservative approach, represents zero cohesion and a low enough friction angle such that all strength values within the anticipated stress range are above this lower bound.

4.3 SEISMIC STRENGTH CONSIDERATIONS

Beyond the undrained strength properties determined from the strength tests discussed above, assessment of potential loss of undrained strength as a result of seismic ground shaking is another important consideration for the stability evaluation of the landfill slope. In general, materials underlying the OLF at the RFETS are not expected to be susceptible to significant pore water pressure buildup during seismic loading, or exposed to drastic reduction in cyclic shear strength during cycling loading from seismic shaking. A summary of material properties that lead to indicate their cyclic strength behavior is provided below.

Fill materials, when compacted would not be susceptible to a significant loss of strength, whether or not they are of a cohesive nature. Uncompacted fill, such as the OLF waste mixed with significant amounts of Rocky Flats Alluvium, although it would generally not be as dense as in its natural condition, contains significant amounts of clay, and thus is not expected to lose significant amounts of strength during shaking. It is possible, however, that localized pockets, where uncompacted cohesionless granular material may have become saturated, could be adversely affected by seismic shaking. Even in this case, the situation would be considered to have limited lateral extent and thickness and would not be anticipated to constitute a generalized condition under significant portions of the landfill site.

Rocky Flats Alluvium underlying the upper portions of the OLF slope, while containing a significant fraction of granular materials, are fairly dense, and also include a clay matrix that significantly reduces, if not completely eliminates, the potential for a rapid increase in pore water pressure due to cyclic loading. This is consistent with the findings of Geomatrix Consultants (1994), indicating that sandy and gravelly fractions were generally dense, with blow counts on the order of 38 $\pm$ 14 bpf and 41 $\pm$ 13 bpf, respectively. Similarly, clayey soil fractions were very stiff with blow counts on the order of 28 $\pm$ 14 bpf.

Colluvial materials, which contain significant amounts of cohesive soils (clay) and claystone bedrock materials, are highly cohesive and very stiff to hard, and therefore are not anticipated to be prone to a significant amount of pore water pressure buildup and loss of shear strength during seismic shaking.

As a result of these soil and bedrock physical properties, the seismic stability evaluation discussed in the next section, which uses undrained strength properties for the critical clay type colluvium/slide and weathered claystone bedrock materials, is considered to be based on conservative analysis parameters.

5.0 STABILITY ANALYSIS

This section discusses the basis, results, observations, and conclusions of the stability analyses performed to support design of the OLF accelerated action. Two primary components of the analyses are associated with static long-term loading conditions and potential seismic short-term loading conditions applied to the landfill slope. These two different aspects of stability are addressed throughout the various discussions for this section. The key bases and results of the entire stability analyses are provided on Figures 7, 8, and 9. Supporting results from computer-aided analyses of static and pseudostatic methods for all cases and conditions analyzed, as summarized on Figures 7, 8, and 9, are provided in Appendix E. Deformation analysis methods, performed as part of the seismic stability analysis, are discussed in detail in Appendix F.

5.1 CRITERIA

Criteria for the static stability analysis and seismic stability analysis are presented in the following sections. This includes regulatory guidance for seismic evaluation procedures.

5.1.1 Static Stability

Static stability under long-term, steady state conditions, evaluated in general accordance with conventional two-dimensional limit equilibrium analysis, is required to achieve a minimum static safety factor of 1.5. This value is typical of earthfill embankments and is required by most agencies and design guidelines, and it is also used for solid waste landfills.

5.1.2 Seismic Stability

Generally acceptable methods of slope stability analysis for assessing the seismic stability of earthfills, including in highly seismic areas of the western United States, are summarized below. These procedures are described in guidelines implemented by several state agencies (i.e., California Division of Mines and Geology [CDMG], 1997). In recent years, these procedures were extended to solid waste landfill structures once appropriate parameters for the analysis of landfills were developed (Kavazanjian, 2002; Bray, 1995).

- The pseudostatic stability analysis is a method that may be used in conjunction with a predetermined horizontal seismic coefficient. The seismic coefficient results in an "equivalent" static horizontal acceleration at the center of gravity of a potential sliding earthfill mass in a conventional limit-equilibrium analysis. This is the simplest approach to a dynamic slope stability calculation, and is one of the most often used in current practice and is generally considered to be a conservative approach.

  Although there is no specific guidance regarding the selection of seismic coefficients in pseudostatic analyses for solid waste landfills, pseudostatic slope stability analysis is often performed using a seismic coefficient estimated from procedures developed for earth embankments.

  A range of seismic coefficients and pseudostatic factors of safety, that have been used in engineering practice and referenced in the literature for earthfill structures, generally fall within a trapezoidal area as shown on Figure 1 of CDMG (1997) guidelines (reproduce as Figure F1 in Appendix F of this report), for jurisdictions where pseudostatic coefficients have not been adopted by the lead agency. This figure presents a summary of the recommended values of the seismic coefficient for the ranges of factor of safety and earthquake parameters presented in publications by Seed (1979) and Hynes & Franklin (1984). Seismic coefficients as high as one half of the peak horizontal acceleration in rock have been used, in combination with pseudostatic factors of safety of 1.0 to 1.15 for earth structures.

  It is also noted that a pseudostatic analysis is not considered necessary in cases where the static factor of safety is at least 1.7 for earthfill structures (Hynes and Franklin, 1984).

- A simplified seismically-induced permanent displacement analysis of earthfill slopes, which includes design chart solutions, such as those proposed by Makdisi and Seed (1978), based on previous work by Newmark (1965), is a secondary method used in seismic stability analysis when pseudostatic analysis is an inadequate model.

  The original Newmark procedure involves calculation of the yield acceleration, defined as the inertial force required to cause the static factor of safety to reach 1.0 from the traditional limit-equilibrium pseudostatic analysis. The procedure uses a design earthquake strong motion record and calculates cumulative displacements above the yield acceleration.

  Makdisi and Seed's procedure seeks to define seismic embankment stability in terms of acceptable deformation in lieu of conventional factors of safety, using a modified Newmark analysis. This method presents a rational approach to determine the yield acceleration, including dynamic characteristics and deformability of the fill slopes, and average acceleration of the potential sliding mass. Design curves are used to estimate the permanent earthquake-induced deformations of embankments 100 to 200 feet high, based on previous well-documented cases analyzed by more sophisticated techniques. These methods have been applied to solid waste landfills and highway embankments.

Additional details of the Makdisi and Seed procedure, which has been selected for the seismic analysis of the OLF, have been summarized in Appendix F of this report.

Further work on amplification or deamplification of acceleration potential of landfills was conducted Bray et al. (1998), by including not only the effect of the fundamental period and dynamic parameters of solid waste landfills in the evaluation of the maximum horizontal acceleration, but also the predominant period of the rock motion.

- More complex deformation analyses include numerical methods, such as the use of dynamic finite elements (such as QUAD4) or finite difference mathematical models, or one-dimensional (such as SHAKE) analyses, for selected acceleration time histories. These more complex analyses have been used in highly seismic areas of the western United States for structures that pose high risk to human life and property, where the above indicated "simplified" procedures (pseudostatic analysis, simplified displacement analysis) were either not applicable or did not yield conclusive results. This last category of analysis methods is not considered necessary for the OLF site.

In addition to selection of the appropriate sophistication level of the above standard methods being part of the analysis criteria, regulatory requirements and guidelines also can control analysis criteria. As summarized in Earth Tech's memorandum dated May 26, 2004 (Slope Stability Evaluation – Seismic Issues), State of Colorado hazardous waste regulations (Colorado Code of Regulations [CCR] 1007-3) and solid waste regulations (Colorado Code of Regulations [CCR] 1007-2) are generally silent regarding the seismic stability evaluation and design of landfills. These regulations are consistent with the Code of Federal Regulations (CFR) for Hazardous Wastes 40 CFR Parts 258 and 260-279.

Though there are no specific guidelines regarding the seismic analysis of the landfills at RFETS, the following paragraphs summarize examples of seismic design guidelines that have been developed for high-risk structures such as dams.

- The Colorado rules and regulations for dam safety and dam construction state:

  1. The minimum acceptable pseudo-static stability analysis factor of safety is 1.0, and shall be attainable using a pseudo-static load coefficient of one-half the predicted peak bedrock acceleration (g's), but not less than 0.05.

  2. For those Class I dams, and large and intermediate Class II dams, for which a pseudo-static analysis is not appropriate, as determined by Rule 5.A. (6)(j)(IV), a deformational analysis shall be performed in a manner acceptable to the State

Engineer. The freeboard remaining due to deformation of the dam shall not be less than three feet.

- USCOLD (1999) states that "If the embankment or the foundation materials are not susceptible to [significant] loss of strength or stiffness [i.e., liquefaction], and if the level of ground motion to be considered does not exceed 0.40g to 0.50g, then simplified methods may be sufficient to estimate the permanent deformations potentially induced by the ground motion."

- Utah (2002) states that "For a maximum acceleration of 0.2g or less, or a maximum acceleration of 0.35g or less if the embankment consists of clay on clay or bedrock foundation, a pseudostatic coefficient which is at least 50 percent of the maximum peak bedrock acceleration at the site should be used in the stability analysis. The minimum factor of safety in an analysis should be 1.0." If the ground shaking noted above is exceeded: "a deformation and settlement analysis should be performed to estimate anticipated total crest movement."

- Washington (1993) notes that seismic analyses are not required if all of the following are met: "1) The dam is well-built (densely compacted) and peak accelerations are 0.2g or less, or the dam is constructed of clay soils, is on clay or rock foundations and peak accelerations are 0.35g or less; 2) The slopes of the dam are 3 horizontal to 1 vertical or flatter; 3) The static factors of safety of the critical failure surfaces involving the crest …. are greater than 1.5 under loading conditions expected prior to an earthquake; and 4) The freeboard at the time of the earthquake is a minimum of 2 to 3 percent of the embankment height (not less than 3 feet) …".

- State of California (Department of Conservation, Division of Mines and Geology) Special Publication 117: Guidelines for Mitigating Seismic Hazards in California, refers the selection of the Seismic Coefficient to research by the U.S. Army Corps of Engineers (Miscellaneous Paper: GL-84-13: "Rationalizing the Seismic Coefficient Method," authored by Hynes and Franklin, 1984) which provided amplification factors to be used when considering the crest of an embankment in comparison with amplifications at the base, with the intention of identifying those embankments which could be expected to experience unacceptable deformations. They suggested using one-half the bedrock acceleration applied to the embankment crest with an acceptable factor of safety greater than 1.0, and limited the assessment to earthquakes of less than magnitude 8 with nonliquefiable materials comprising the embankment. A reduction on material static undrained shear strengths up to 20 percent may be applicable depending on the nature and cyclic behavior of soils.

It should be noted that the above-listed requirements pertain to high risk dam structures whose failure could result in immediate loss of human life and/or significant property damage. The RFETS OLF is not this type of high risk structure.

Considering the project site setting, geologic conditions, standard of practice, and regulatory requirements, the following seismic stability analysis criteria were adopted for the OLF site:

- Minimum required pseudostatic safety factor of 1.0 using a seismic coefficient of one half the peak horizontal bedrock acceleration. For the case of the OLF, one-half of the peak horizontal bedrock acceleration represents 0.06g.
- Seismically-induced permanent displacement less than 12 inches, the generally accepted standard of practice for landfill covers, for the selected design earthquake event, should the pseudostatic safety factor be less than 1.0.

5.2 BASIS OF ANALYSIS

The Phase 3 stability analysis was performed on the following bases:

- Use of existing geologic cross sections from the M&E report. The most critical section through the landfill is not obvious; analyses were performed on the three existing cross sections encompassing the waste and past slide materials across the entire hillside slope which are believed to bracket the typical and most critical stability conditions (M&E geologic cross sections B-B', C-C', and D-D').
- Use of density and strength material parameters established on Figures 7, 8, and 9. Material properties were selected based on Phase 2b field and laboratory geotechnical data collected as part of this investigation (Figures 2 through 6, Appendices A and B), supplemented by the results of previous investigations at the project site by Metcalf & Eddy (1995). Strength values represent a lower bound friction angle with zero cohesion, which is a lower bound for all strength values within the anticipated stress range.
- Use of groundwater levels generated from the hydrogeologic modeling described earlier (Appendix D).
- Comparison of analyses factor of safety results to minimum required criteria of 1.5 for static conditions and 1.0 for seismic conditions using a pseudostatic analysis. Comparison of estimated seismically induced permanent displacement to maximum allowed 12 inches for pseudostatic analysis cases yielding a safety factor less than 1.0.

5.3 CONDITIONS ANALYZED

Geometric conditions analyzed in the Phase 3 stability analyses associated with the project alternatives, as depicted on Figures 7, 8, and 9, are as follows:

- Existing ground surface and slope, per the M&E geologic cross sections.

- Overall 18 percent regraded cover slope superimposed over existing ground surface topography.

- Stability buttress at the toe of the landfill with the 18 percent regraded slope.

For each of the various variable conditions used as the bases of analyses, the following conditions were analyzed, in terms of general mechanisms of potential sliding and the approach to searching for potential failure surfaces with minimum factors of safety for each case analyzed:

- Circular failure surface search through all materials in the landfill slope above the unweathered claystone bedrock.

- Sliding block failure surface search within the critical colluvium/slide and weathered claystone bedrock materials, as depicted on the M&E geologic cross sections.

- Shallow sliding potential in regraded cover materials.

For each of the various geometric conditions and potential sliding mechanisms considered, the stability was analyzed for two groundwater conditions, as follows:

- Average wet year climate conditions (Appendix D).
- 100-year wet year climate conditions (Appendix D).

For each of the various conditions and cases considered, analyses were performed for both static and seismic conditions. Seismic conditions were analyzed initially using a pseudostatic analysis approach with a horizontal force seismic coefficient of 0.06g. The simplified deformation analysis was also employed for the various cases analyzed.

In addition, a check was made of surficial sliding potential in regraded cover materials based on saturated ground conditions.

5.4 METHODOLOGY

Stability analyses of the landfill slope for various project alternatives were conducted in the following evaluation/computational sequence:

- Static slope stability analysis and selection of potential critical slip surfaces.

- Pseudostatic slope stability analysis and evaluation of yield acceleration seismic coefficient.
- Determination of average acceleration of potential slide mass under selected design conditions for seismic shaking.
- Estimation of seismically induced permanent displacement for the selected design earthquake event using simplified deformtion analysis.

These four stages of the analysis are described in the following sections.

To assess permanent, long-term steady state stability of the landfill, conventional two-dimensional limit-equilibrium stability analyses methods were performed for static conditions. The limit equilibrium methods were also employed for an initial, simplified assessment of seismic stability using the assigned seismic coefficient of 0.06 g for pseudostatic conditions. Factors of safety against sliding using circular arc and sliding block failure surfaces were computed for both the static and pseudostatic analyses. For the approach taken of assigning a uniform lower bound strength to the most critical colluvium/slide and weathered claystone materials, which is conservative, and considering the geometry of the landfill slope and subsurface material layers, either circular arc or sliding block failure modes could be critical, and these methods of modeling potential critical failure surfaces used for the stability analyses are appropriate.

The landfill slope for the various conditions previously discussed was computer-analyzed for circular arc failure modes using Bishop's modified method and for sliding block failure modes using Janbu's modified method. These methods incorporate, as basic input data, the geometry of the slope and subsurface material layers, unit weight and shear strength properties of the soil and bedrock materials, and the distribution of boundary and internal water forces. After a failure surface has been assumed, the soil mass above the sliding surface is divided into a series of vertical slices. Forces acting on each slice include the earth pressures on its sides, water pressures on its sides and bottom, effective earth pressures with associated friction acting on the assumed sliding surface, and cohesion along the sliding surface. Various trial failure surfaces are analyzed until a minimum factor of safety is obtained for the case being studied.

The modified Bishop and Janbu methods are generally conservative and efficient methods of analysis used for initial extensive screening of potential slip surfaces. In addition, the Spencer method, being a more rigorous method of slope stability analysis, was used to check the most critical cases identified by searching methods employed by the modified Bishop and Janbu methods. Spencer's method satisfies both force and moment equilibrium of the sliding mass, whereas the modified Janbu and Bishop methods satisfy only force and moment equilibrium, respectively. Further, the most critical slope stability results were also independently evaluated as part of normal quality control procedures.

The various computational methods discussed above were performed by computer analyses. The computer program PC STABL 5M, developed at Purdue University, was used to perform the stability analyses. The program performed automatic searches of different potential failure surfaces to determine the most critical surface having the lowest factor of safety for the condition being analyzed.

For seismic stability analysis required beyond the initial, simplified pseudostatic analysis check, the Makdisi and Seed procedure for computation of seismically induced permanent displacement was employed . The methodology of this procedure, which is widely accepted in geotechnical earthquake engineering and state-of-practice in seismic stability evaluation of landfill slopes, is detailed separately in Appendix F of this memorandum.

For the surficial stability check of anticipated cover materials, an infinite slope analysis method of calculation was used.

5.5 RESULTS

The results of computer-aided stability runs for the various combinations of three cross sections, established soil and bedrock density and strength parameters, three geometric conditions, circular arc and sliding block potential failure mechanism searches, and two different groundwater conditions, for both static and seismic conditions, are provided and summarized on Figures 7, 8, and 9 for the M&E geologic sections B-B', C-C', and D-D', respectively. The results can be summarized as follows:

- The analysis of geologic section B-B' appears most critical. However, there are only subtle, minor differences in minimum safety factor results between the various cross sections analyzed.

- Results obtained from analyses of potential sliding block surfaces are slightly more critical, by only a difference of 0.1 on the safety factor, or the same as results of the analyses of potential circular arc sliding surfaces in all cases analyzed. This is consistent with the geometric configuration of the critical colluvium/slide and weathered claystone bedrock material layers oriented beneath the long flat landfill slope.

- For the two climatic conditions modeled by two slightly different groundwater levels, results indicate a maximum difference in safety factors of 0.1.

- All cases analyzed for existing topographic conditions have safety factor results equal to or less than 1.5 for static analysis and less than 1.0 for pseudostatic analysis.

- All cases analyzed for the 18 percent regrade condition have safety factor results ranging from 1.5 to 1.7 for static analysis and less than 1.0 for pseudostatic analysis.

- All cases analyzed for the 18 percent regrade with buttress condition have safety factor results ranging from 1.7 to 1.9 for static analysis and ranging from 0.9 to 1.0 for pseudostatic analysis.

- All cases analyzed for existing topographic conditions have estimated maximum seismically induced permanent displacement results ranging from 10 to over 12 inches.

- All cases analyzed for the 18 percent regrade condition have estimated maximum seismically induced permanent displacement results ranging from 5 to 10 inches.

- All cases analyzed for the 18 percent regrade with buttress condition have estimated maximum seismically induced permanent displacement results ranging from 3 to 5 inches.

- For the surficial stability check of anticipated cover materials, static and pseudostatic safety factors for saturated slope conditions are acceptable (Appendix E).

In addition to the summary of specific results for each case and condition analyzed, in terms of safety factor against sliding and maximum permanent displacement for seismic shaking, all analyses input variables are listed and illustrated on the results Figures 7, 8, and 9. Selected material parameters are listed in a summary table against a key for each subsurface material type. Geologic cross sections reflecting the three project alternative geometric conditions analyzed are provided adjacent to associated stability analyses results and depicting the distribution of hillside materials and groundwater levels. On these geologic sections, for each of the geometric conditions analyzed, typical critical circular arc and sliding block surfaces are illustrated.

Backup of all computer runs showing both the critical sliding surface identified and all surfaces analyzed in the analysis search in a graphic form similar to the cross sections on Figures 7, 8, and 9, for all cases and conditions computed, are provided in Appendix E, organized to correspond to the summary of results on Figures 7, 8, and 9.

5.6 OBSERVATIONS AND CONCLUSIONS

Based on the findings of this geotechnical investigation and specifically the results of the stability analysis performed for the accelerated action alternatives, major observations and conclusions are as follows:

- The primary factor controlling the stability of the existing landfill slope and any regrading modification to it, for both local shallow instability and overall deeper instability potential, is the strength of the colluvium/slide and underlying weathered claystone bedrock materials beneath the landfill site.

- Groundwater conditions within the landfill hillside slope play a significant role in stability conditions from the standpoint of both effect on material strength of the clay type materials comprising the colluvium and weathered bedrock and hydrostatic loading conditions within the landfill slope.

- The criteria used in this analysis of 1.5 factor of safety for the static condition, 1.0 factor of safety using one-half of the peak bedrock acceleration for pseudostatic analyses, and permanent seismically-induced deformations less than 12 inches are consistant with guidance as outlined in Section 5.1.

- The current, more obvious existing evidence of local and surficial instability at the site, of lesser consequence, will be mitigated by improved control of surface water and improvement of material type and strength in slope regrading planned for the accelerated action.

- The critical potential sliding mechanism for lower probability, more massive and deeper instability, which would be of greater consequence, is a large sliding block configuration or a broad circular arc surface involving a majority of the slope with the sliding surface within the weakest colluvium and weathered claystone bedrock matetrials.

- All conditions analyzed for modifications to the landfill slope as part of accelerated action alternatives, either by regrading the slope to the overall 18 percent configuration or by regrading with a stability enhancing buttress, meet or exceed the minimum required safety factor of 1.5 for long term static conditions and would limit maximum seismically induced permanent displacement from seismic shaking under design seismic conditions to less than the maximum 12-inch established design criteria.

- A buttress at the toe of the landfill slope provides enhancement to the overall landfill slope stability, but very subtle improvement for the size and configuration analyzed, approximately 20 feet high, extending about 50 feet beyond the existing slope toe, with a 2.5 to 1, horizontal to vertical, side slope.

- The results of the static and seismic stability analyses do not conclude that stability enhancement beyond the slope regrading condition is required.

Some final observations and conclusions regarding aspects of this investigation that are considered conservative to the results of the stability analysis and design of the accelerated action are as follows:

- Strength parameters used for the critical materials controlling stability results are conservative lower bound values of all test data within the anticipated stress range.

- Neglecting cohesion in the somewhat overconsolidated clay type colluvium and weathered bedrock materials, as established in material parameter selection, particularly for the undrained strength used for short term seismic loading, is conservative to the stability analysis results.

- The highest groundwater condition analyzed in combination with seismic loading is quite conservative, as the likelihood of both these conditions occurring simultaneously is low.

- The 12-inch maximum displacement criteria for seismically induced deformation could be considered conservative, as only a soil cover, with no deformation sensitive design components, such as synthetic liners and piping systems, is anticipated for the accelerated action design.

- The 18 percent regrade design slope is conceptual in nature. Further refinement of this regraded slope with further consideration given to surface water management, groundwater elevations, and bedrock elevations will improve stability issues.

5.7 CONCEPTUAL ACCELERATED ACTION DESIGN

As a result of the data presented and reviewed in this report, the results of static and seismic stability analyses, and past design experience, it is concluded that no stability enhancement beyond slope regrading is required to meet established design criteria for the accelerated action at the OLF.

6.0 REFERENCES

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FIGURES

IDs	NORTHING	EASTING
B1	747670.5	2081135.9
B2	747653.6	2081412.1
B3	747690.3	2081596.9
B4	747699.9	2081810.9
B5	747673.6	2081992.8
B6	747715.6	2082165.6
B7	747718.1	2082487.5
B8	747544.3	2081816.6
B9	747553.3	2081975.5
B10	747807.8	2081991.1
TP1	747570.4	2081455.0
TP2	747543.6	2082153.4
TP3	747783.9	2082436.9
TP4	747614.6	2082495.5
TP5	747547.8	2082506.9
TP6	747627.5	2082836.3

LEGEND

- UNDERGROUND GAS LINE MARKER
- MONITORING WELL
- CONCRETE PAD
- UTILITY POLE
- UTILITY POLE (STUB)
- OVERHEAD WIRE
- RAILROAD TRACK
- LIMIT OF WASTE

PHASE 2b - PROPOSED ADDITIONAL FIELD INVESTIGATION

- GEOTECHNICAL BOREHOLE (SEE NOTE BELOW)
- BACKHOE TEST PIT

NOTE: UP TO 2 ADDITIONAL BOREHOLES ASSUMED, ADJACENT TO SELECTED LOCATIONS SHOWN FOR ADDITIONAL SAMPLING NEEDS. B8 AND B9 SUBJECT TO ACCEPTABILITY FOR DRILLING AT THESE LOCATIONS. B8, B9, AND B10 SUBJECT TO TRUCK MOUNTED DRILL RIG ACCESSIBILITY.

EARTH TECH

FIGURE 1
ORIGINAL LANDFILL
GEOTECHNICAL INVESTIGATION
SAMPLING LOCATIONS
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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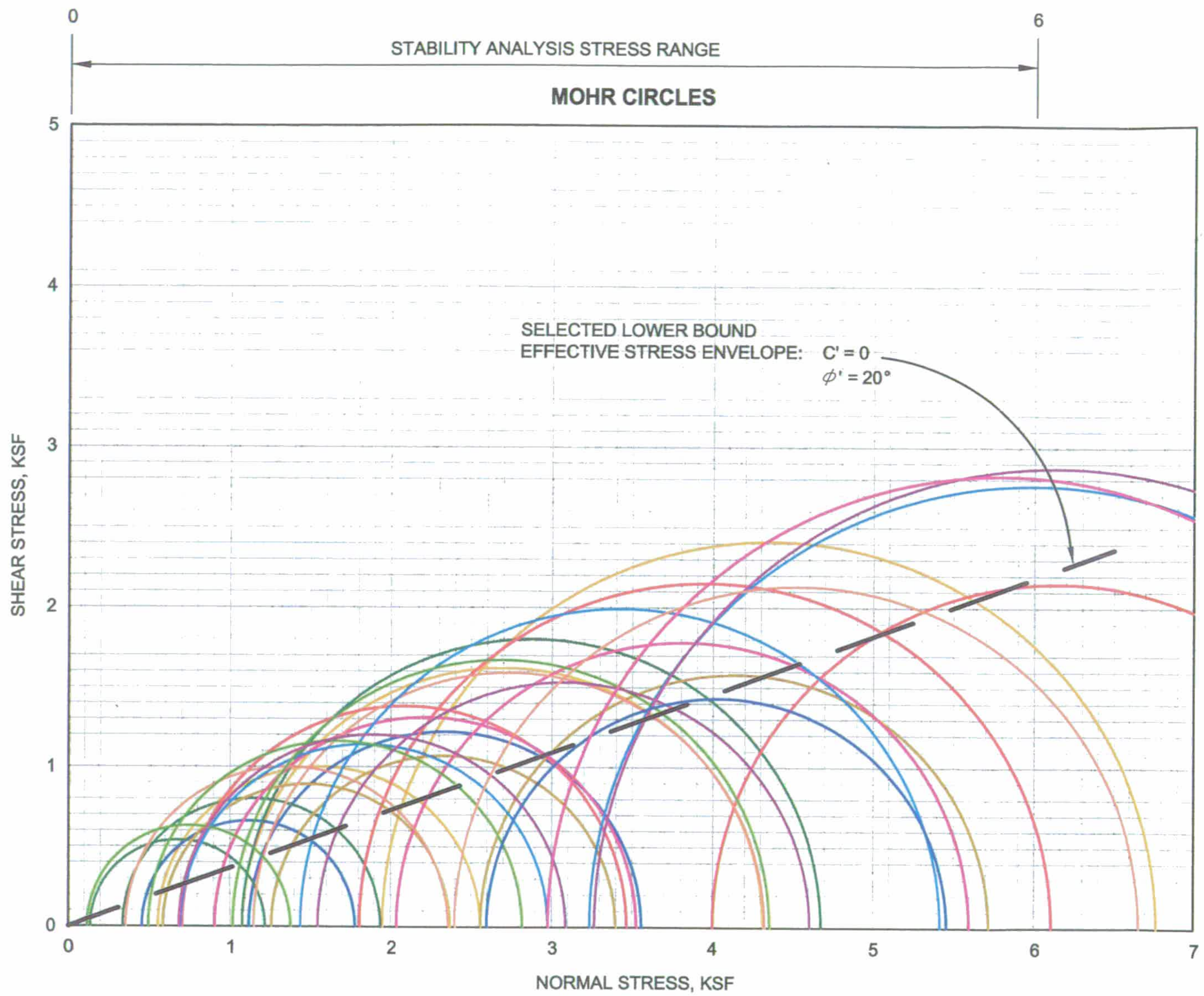

ICU TRIAXIAL TEST RESULTS

KEY	MATERIAL[1]	LOCATION	SAMPLE	DEPTH (feet)	USCS[2]	DENSITY (pcf)	DRAINED STRENGTH[3] COHESION (psf)	FRICTION ANGLE (degrees)
	CSSW	TP1	L1 L2 L3	14 14 14		125 127 125	300	30
	CSSW	TP4	L1 L2 L3	10 10 10		121 122 127	400	15
	CSSW	TP6	L1 L2 L3	7 7 7		126 126 130	200	34
	CSMW	B3	S2	18-20.5	CH	130 129 127	300	17
	Qc	B4	S2	12-14.5	CH	125 120 122	500	15
	CSSW	B4	S3	14.5-17	CH	129 125 125	500	22
	CSSW	B6	S1	11-13.4	CH	123 128 124	600	20
	CSSW	B7	S1	13-15	CH	128 128 127	400	24
	Qc	B8	S1	6-8.2		120 121 122	300	30
	CSMW	B7	L7 L8 L9	17.5-18 18-18.5 18.5-19	CH	122 125 120	600	19

[1] Qc = COLLUVIUM/SLIDE, CSSW = SEVERELY WEATHERED CLAYSTONE, CSMW = MODERATELY WEATHERED CLAYSTONE

[2] UNIFIED SOIL CLASSIFICATION, BASED ON GRADATION AND ATTERBERG LIMITS

[3] BASED ON MAXIMUM PRINCIPAL STRESS RATIO FAILURE CRITERIA, EFFECTIVE STRESS PARAMETERS

E A R T H T E C H

FIGURE 2

ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION
TRIAXIAL SHEAR TEST DATA - DRAINED STRENGTH

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

NOVEMBER 2004

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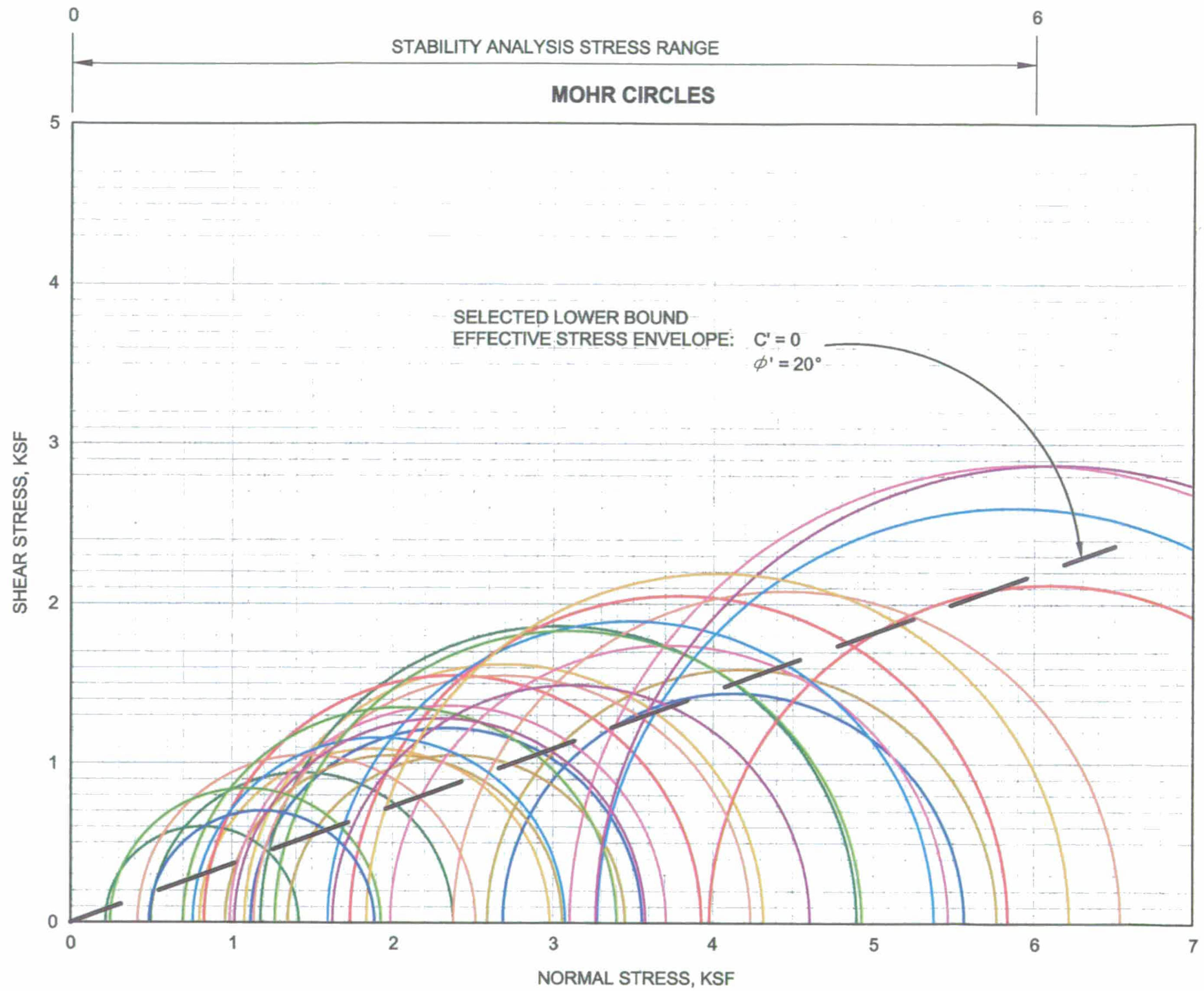

ICU TRIAXIAL TEST RESULTS

KEY	MATERIAL[1]	LOCATION	SAMPLE	DEPTH (feet)	USCS[2]	DENSITY (pcf)	DRAINED STRENGTH[3]	
							COHESION (psf)	FRICTION ANGLE (degrees)
	CSSW	TP1	L1 L2 L3	14 14 14		125 127 125	150	30
	CSSW	TP4	L1 L2 L3	10 10 10		121 122 127	400	15
	CSSW	TP6	L1 L2 L3	7 7 7		126 126 130	150	35
	CSMW	B3	S2	18-20.5	CH	130 129 127	700	16
	Qc	B4	S2	12-14.5	CH	125 120 122	450	16
	CSSW	B4	S3	14.5-17	CH	129 125 125	500	22
	CSSW	B6	S1	11-13.4	CH	123 128 124	600	20
	CSSW	B7	S1	13-15	CH	128 128 127	400	24
	Qc	B8	S1	6-8.2		120 121 122	400	28
	CSMW	B7	L7 L8 L9	17.5-18 18-18.5 18.5-19	CH	122 125 120	500	19

[1] Qc = COLLUVIUM/SLIDE, CSSW = SEVERELY WEATHERED CLAYSTONE, CSMW = MODERATELY WEATHERED CLAYSTONE

[2] UNIFIED SOIL CLASSIFICATION, BASED ON GRADATION AND ATTERBERG LIMITS

[3] BASED ON 5 PERCENT STRAIN FAILURE CRITERIA, EFFECTIVE STRESS PARAMETERS

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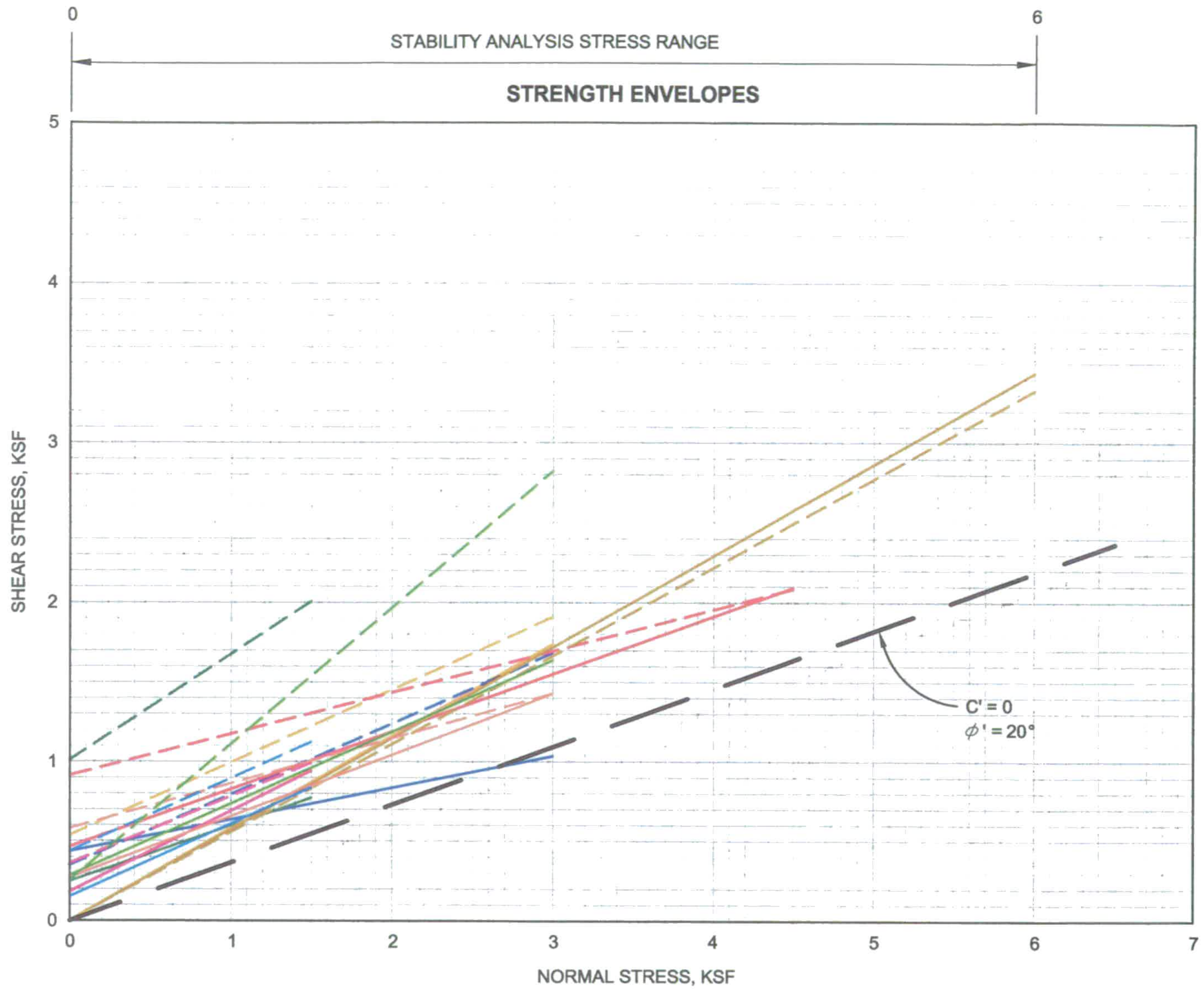
EARTH TECH

FIGURE 3

ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION
TRIAXIAL SHEAR TEST DATA - DRAINED STRENGTH

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

NOVEMBER 2004 57378



DIRECT SHEAR TEST RESULTS [1]

KEY [2]	MATERIAL [3]	LOCATION	SAMPLE	DEPTH (feet)	USCS [4]	DENSITY (pcf)	PEAK STRENGTH [2] COHESION (psf)	PEAK STRENGTH [2] FRICTION ANGLE (degrees)	RESIDUAL STRENGTH [2] COHESION (psf)	RESIDUAL STRENGTH [2] FRICTION ANGLE (degrees)
	CSSW	TP1	L4	14	CH	124 125 124	535	24.6	0	30.1
	CSSW	TP4	L4	10	CH	101 118 108	346	24.0	434	11.3
	CSSW	TP6	L4	7	CH	134 134 131	1008	33.6	245	19.3
	Qc	B3	L3 L4 L4	15.5-16 16-16.5 16-16.5		126 124 124	912	14.6	463	19.9
	CSMW	B4	L5 L6 L6	19.5-20 20-20.5 20-20.5	CH	122 126 131	0	29.0	0	24.8
	Qc	B7	L2 L3 L3	8.5-9 9-9.5 9-9.5	CL	127 125 124	358	22.9	180	26.9
	CSSW	B7	L4 L5 L6	11.5-12 12-12.5 12.5-13		125 122 122	579	15.8	269	21.1
	CSSW	B9	L5 L7 L8	7-7.5 8.5-9 9-9.5	CH	123 123 127	435	24.6	149	24.6
	CSMW	B10	L5 L6 L6	9.5-10 10-10.5 10-10.5	CH	124 124 124	25	40.6	282	24.3

[1] CONSOLIDATED DRAINED PROCEDURES (EFFECTIVE STRESS PARAMETERS)
[2] DASHED = PEAK STRENGTH, SOLID = RESIDUAL STRENGTH
[3] Qc = COLLUVIUM/SLIDE, CSSW = SEVERELY WEATHERED CLAYSTONE, CSMW = MODERATELY WEATHERED CLAYSTONE
[4] UNIFIED SOIL CLASSIFICATION, BASED ON GRADATION AND ATTERBERG LIMITS

EARTH TECH

FIGURE 4
ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION
DIRECT SHEAR TEST DATA - DRAINED STRENGTH
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO
NOVEMBER 2004
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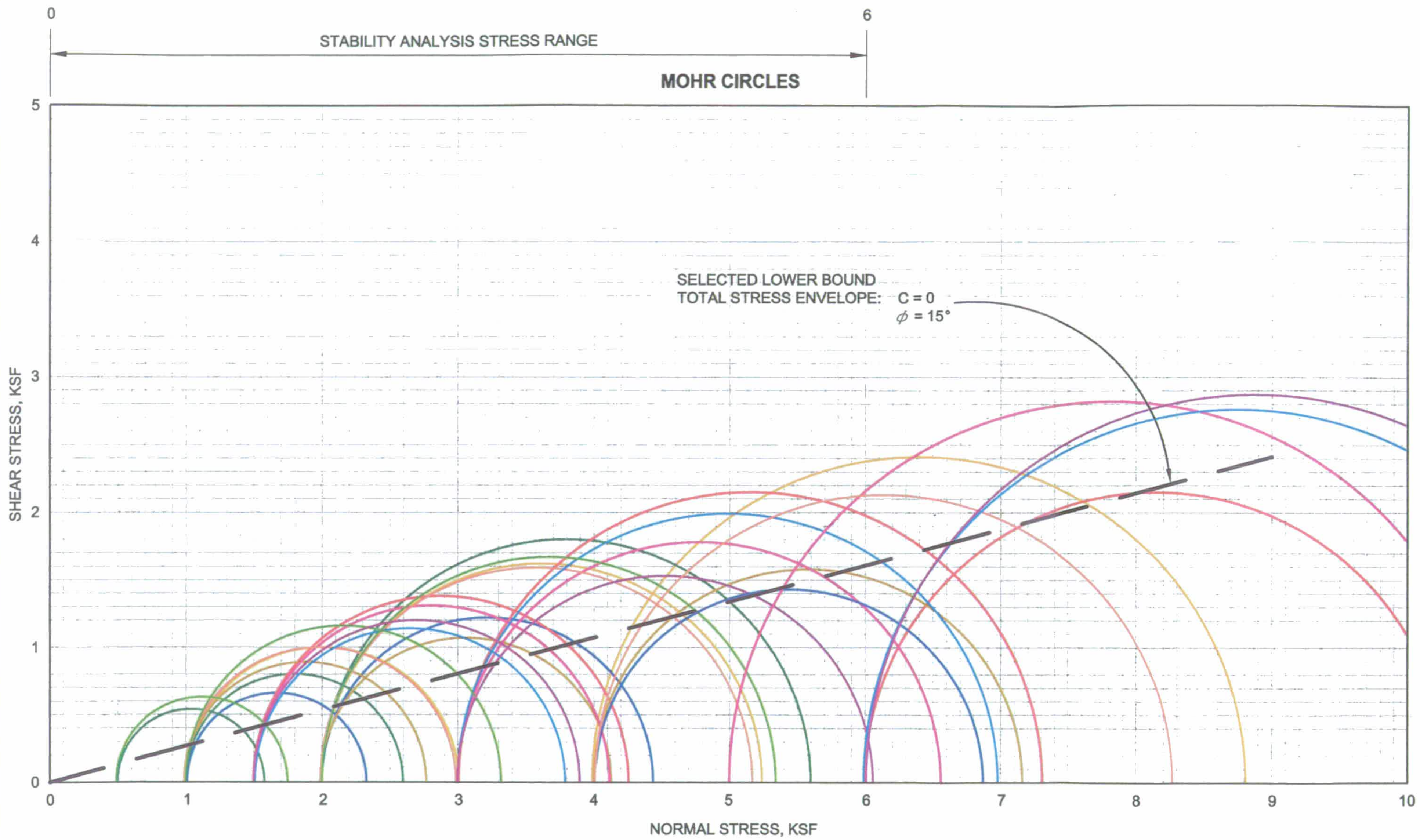

ICU TRIAXIAL TEST RESULTS

KEY	MATERIAL[1]	LOCATION	SAMPLE	DEPTH (feet)	USCS[2]	DENSITY (pcf)	UNDRAINED STRENGTH[3]	
							COHESION (psf)	FRICTION ANGLE (degrees)
	CSSW	TP1	L1 L2 L3	14 14 14		125 127 125	400	19
	CSSW	TP4	L1 L2 L3	10 10 10		121 122 127	300	12
	CSSW	TP6	L1 L2 L3	7 7 7		126 126 130	150	24
	CSMW	B3	S2	18-20.5	CH	130 129 127	600	13
	Qc	B4	S2	12-14.5	CH	125 120 122	500	11
	CSSW	B4	S3	14.5-17	CH	129 125 125	600	15
	CSSW	B6	S1	11-13.4	CH	123 128 124	450	17
	CSSW	B7	S1	13-15	CH	128 128 127	300	18
	Qc	B8	S1	6-8.2		120 121 122	300	24
	CSMW	B7	L7 L8 L9	17.5-18 18-18.5 18.5-19	CH	122 125 120	600	13

[1] Qc = COLLUVIUM/SLIDE, CSSW = SEVERELY WEATHERED CLAYSTONE, CSMW = MODERATELY WEATHERED CLAYSTONE

[2] UNIFIED SOIL CLASSIFICATION, BASED ON GRADATION AND ATTERBERG LIMITS

[3] BASED ON MAXIMUM PRINCIPAL STRESS RATIO FAILURE CRITERIA, TOTAL STRESS PARAMETERS

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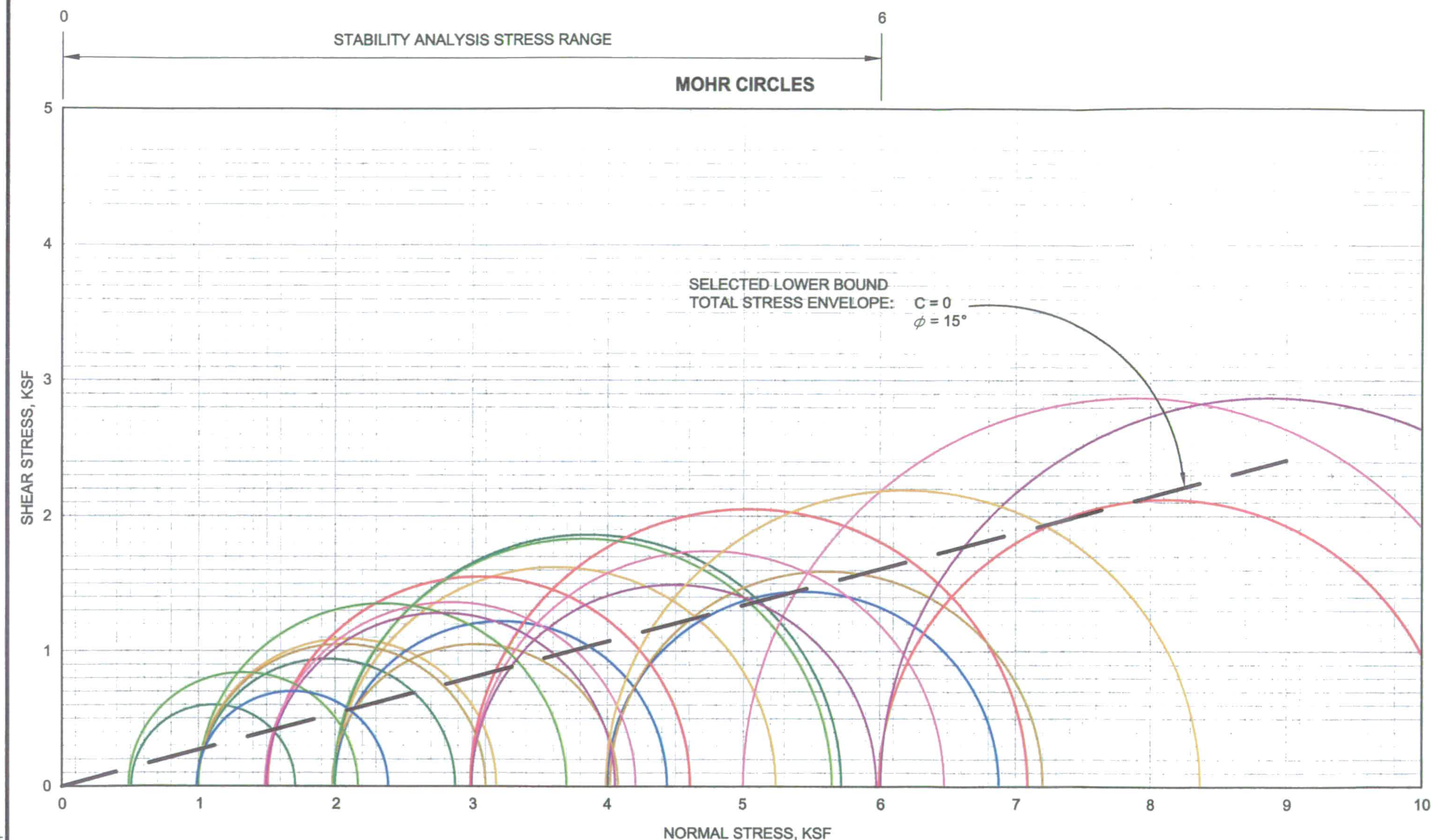
EARTH TECH

FIGURE 5

ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION
TRIAXIAL SHEAR TEST DATA - UNDRAINED STRENGTH

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

NOVEMBER 2004 57378



ICU TRIAXIAL TEST RESULTS

KEY	MATERIAL[1]	LOCATION	SAMPLE	DEPTH (feet)	USCS[2]	DENSITY (pcf)	UNDRAINED STRENGTH[3] COHESION (psf)	FRICTION ANGLE (degrees)
	CSSW	TP1	L1 L2 L3	14 14 14		125 127 125	550	16
	CSSW	TP4	L1 L2 L3	10 10 10		121 122 127	400	11
	CSSW	TP6	L1 L2 L3	7 7 7		126 126 130	100	26
	CSMW	B3	S2	18-20.5	CH	130 129 127	800	11
	Qc	B4	S2	12-14.5	CH	125 120 122	600	10
	CSSW	B4	S3	14.5-17	CH	129 125 125	700	14
	CSSW	B6	S1	11-13.4	CH	123 128 124	500	16
	CSSW	B7	S1	13-15	CH	128 128 127	400	16
	Qc	B8	S1	6-8.2		120 121 122	350	23
	CSMW	B7	L7 L8 L9	17.5-18 18-18.5 18.5-19	CH	122 125 120	700	12

[1] Qc = COLLUVIUM/SLIDE, CSSW = SEVERELY WEATHERED CLAYSTONE, CSMW = MODERATELY WEATHERED CLAYSTONE

[2] UNIFIED SOIL CLASSIFICATION, BASED ON GRADATION AND ATTERBERG LIMITS

[3] BASED ON 5 PERCENT STRAIN FAILURE CRITERIA, TOTAL STRESS PARAMETERS

EARTH TECH

FIGURE 6

ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION
TRIAXIAL SHEAR TEST DATA - UNDRAINED STRENGTH

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

NOVEMBER 2004 57378

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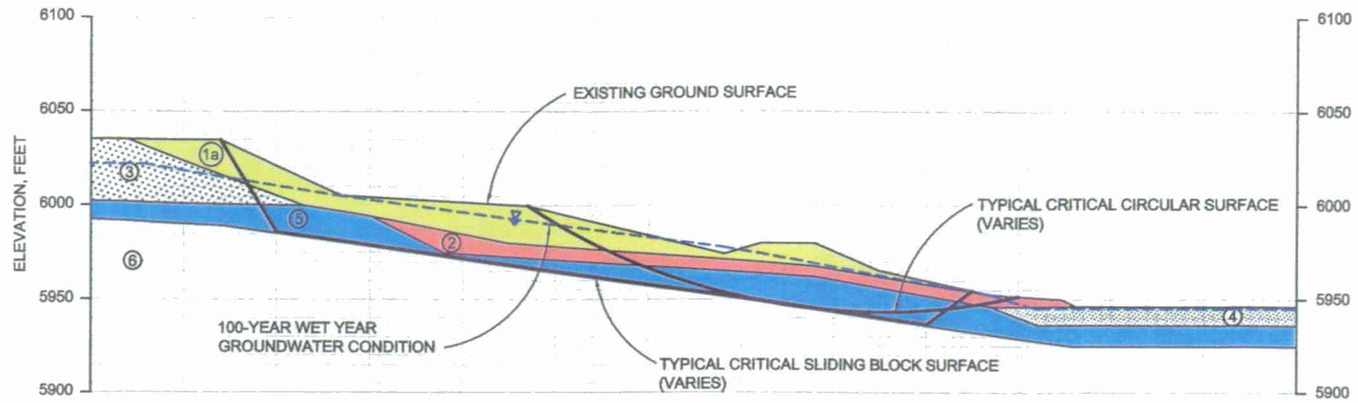
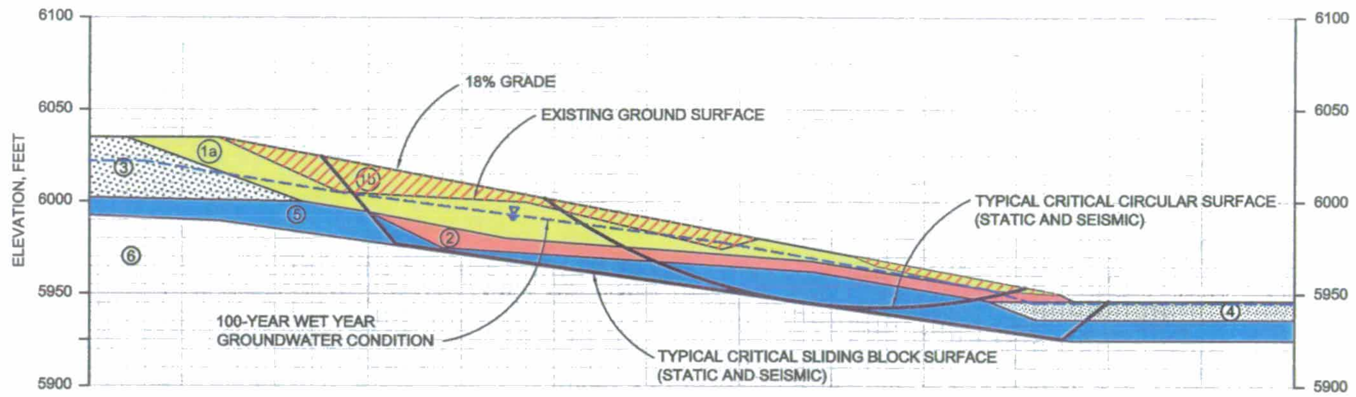
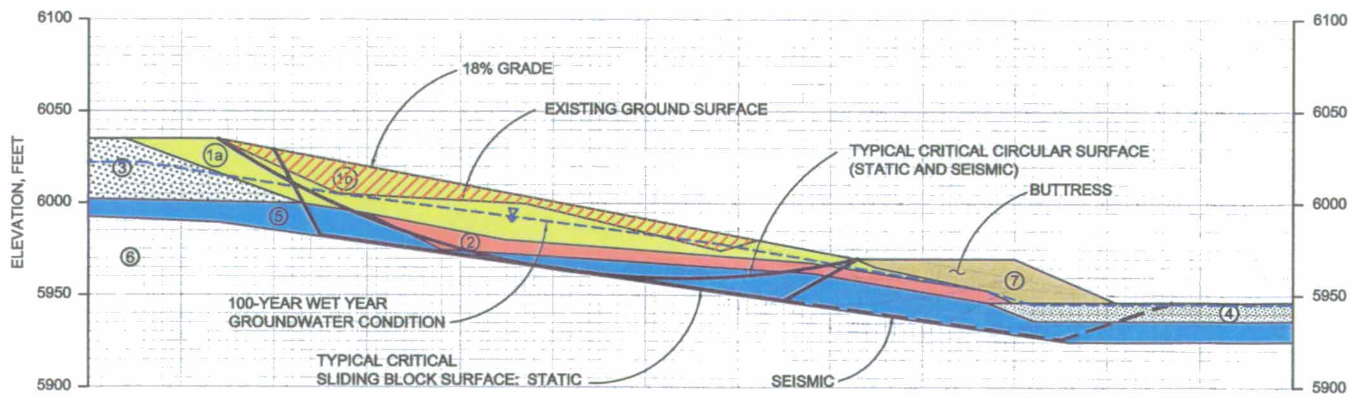


EXISTING CONDITION



18% REGRADE CONDITION



18% REGRADE WITH BUTTRESS CONDITION

STABILITY ANALYSIS SOIL PARAMETERS

KEY	MATERIAL DESIGNATION	DESCRIPTION	UNIT WEIGHT		SHEAR STRENGTH			
					STATIC		SEISMIC	
			MOIST (pcf)	SATURATED (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
	1a	WASTE	120	125	50	30	50	30
	1b	WASTE / FILL / COVER	120	125	50	30	50	30
	2	COLLUVIUM / SLIDE	120	125	0	20	0	15
	3	ROCKY FLATS ALLUVIUM	120	125	0	37	200	30
	4	STREAM ALLUVIUM	125	130	0	33	0	33
	5	WEATHERED CLAYSTONE	120	125	0	20	0	15
	6	UNWEATHERED CLAYSTONE	125	130	600	30	600	30
	7	ENGINEERED FILL	130	135	200	35	200	35

1995 METCALF & EDDY REPORT SECTION B-B'

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GEOMETRIC CONDITION	ANALYSIS TYPE	GROUNDWATER CONDITION	MINIMUM SAFETY FACTOR		YIELD [3] ACCELERATION	MAXIMUM [4] SEISMIC DISPLACEMENT
			STATIC	0.06 g [2]		
EXISTING	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.5	0.8	0.02	10"
		100-YEAR WET YEAR	1.4	0.8	0.01	N/A [5]
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.4	0.8	0.01	N/A [5]
		100-YEAR WET YEAR	1.3	0.8	0.01	N/A [5]
18% REGRADE	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.6	0.9	0.03	6"
		100-YEAR WET YEAR	1.5	0.9	0.02	10"
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.6	0.9	0.03	6"
		100-YEAR WET YEAR	1.5	0.9	0.02	10"
18% REGRADE WITH BUTTRESS	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.7	1.0	0.06	3"
		100-YEAR WET YEAR	1.7	1.0	0.05	4"
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.7	1.0	0.05	4"
		100-YEAR WET YEAR	1.7	0.9	0.04	5"

[1] AVERAGE WET YEAR GROUNDWATER CONDITION, NOT SHOWN ON SECTIONS, IS 1 TO 2 FEET LOWER THAN 100-YEAR WET YEAR GROUNDWATER CONDITION.

[2] SEISMIC COEFFICIENT FOR PSEUDOSTATIC ANALYSIS.

[3] SEISMIC COEFFICIENT THAT PRODUCES SAFETY FACTOR OF 1.0 IN PSEUDOSTATIC ANALYSIS.

[4] ESTIMATED MAXIMUM SEISMICALLY INDUCED PERMANENT DISPLACEMENT USING SIMPLIFIED DEFORMATION ANALYSIS.

[5] PROCEDURE FOR ESTIMATING SEISMICALLY INDUCED PERMANENT DISPLACEMENT BECOMES INVALID, IN THIS CASE, FOR YIELD ACCELERATIONS OF 0.01 AND LESS. MAXIMUM DISPLACEMENT IN THIS CASE LIKELY GREATER THAN 12 INCHES.

0 25 50
SCALE IN FEET

EARTH TECH

FIGURE 7

ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION STABILITY ANALYSES - M&E SECTION B-B'

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

NOVEMBER 2004

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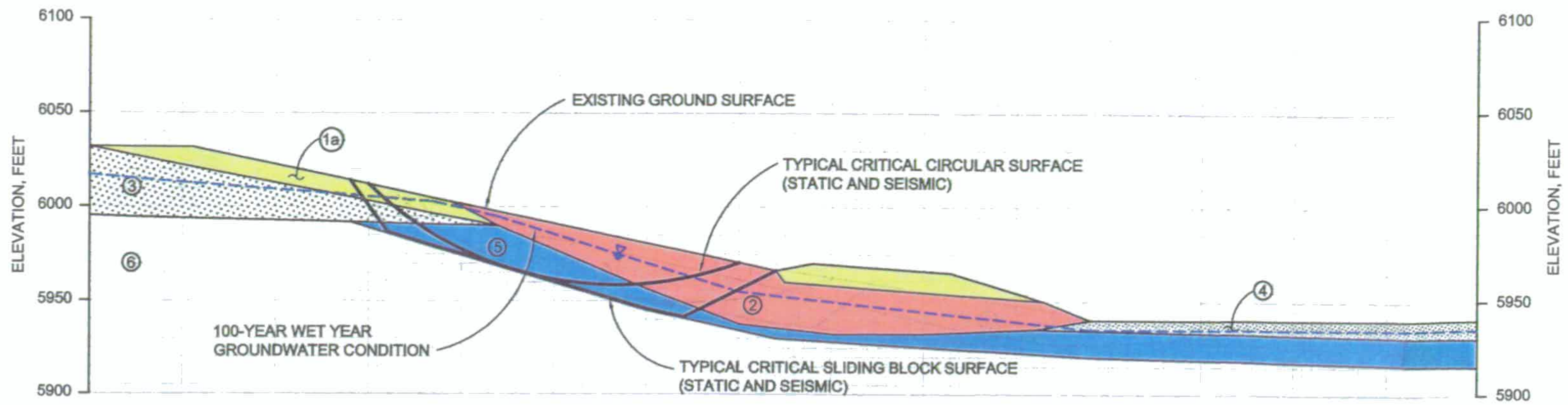
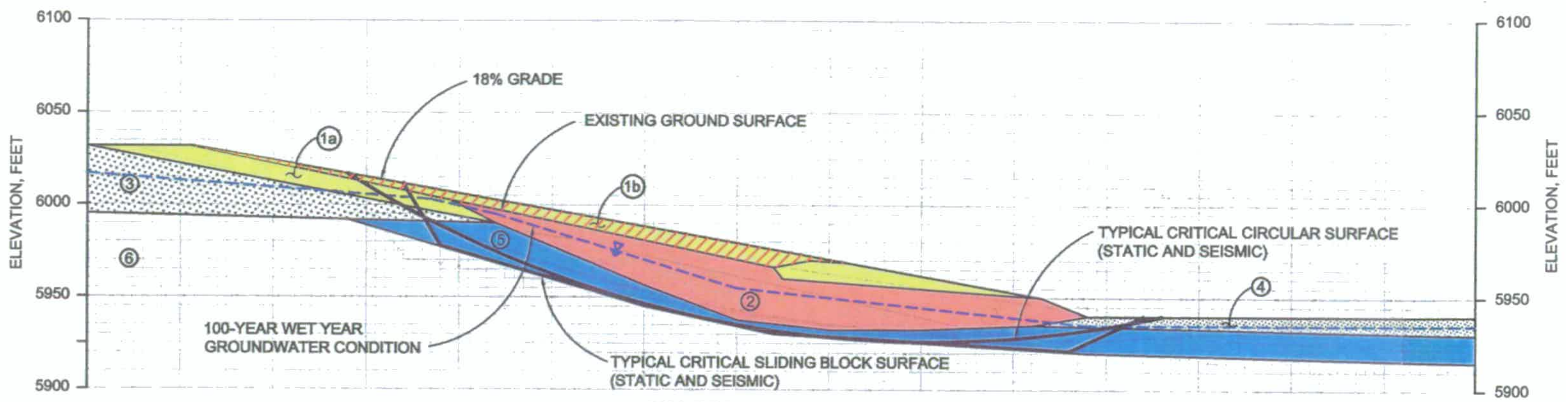
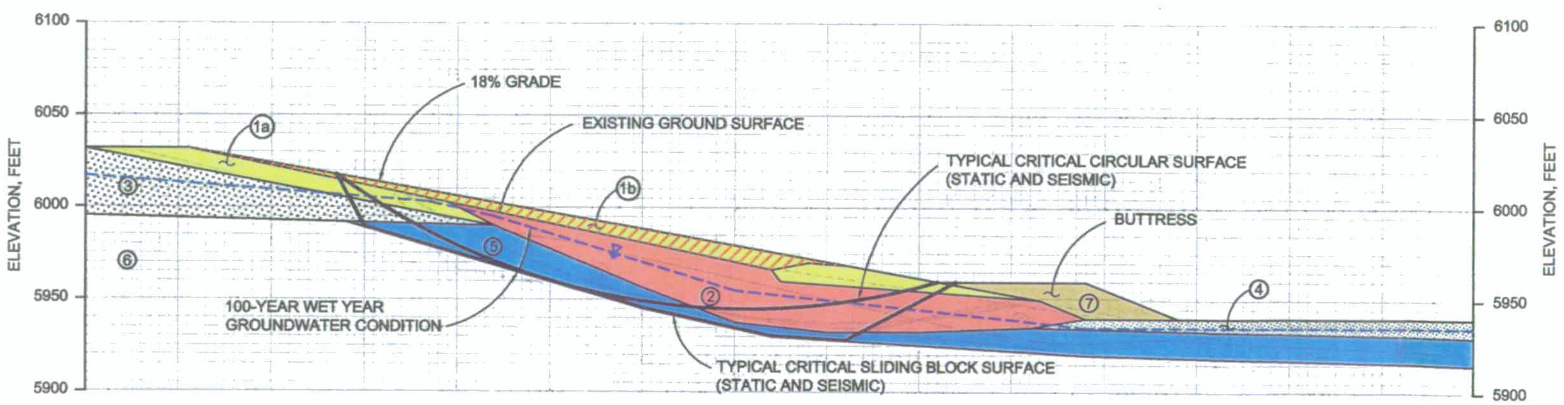


EXISTING CONDITION



18% REGRADE CONDITION



18% REGRADE WITH BUTTRESS CONDITION

STABILITY ANALYSIS SOIL PARAMETERS

KEY	MATERIAL DESIGNATION	DESCRIPTION	UNIT WEIGHT		SHEAR STRENGTH			
					STATIC		SEISMIC	
			MOIST (pcf)	SATURATED (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
	1a	WASTE	120	125	50	30	50	30
	1b	WASTE / FILL / COVER	120	125	50	30	50	30
	2	COLLUVIUM / SLIDE	120	125	0	20	0	15
	3	ROCKY FLATS ALLUVIUM	120	125	0	37	200	30
	4	STREAM ALLUVIUM	125	130	0	33	0	33
	5	WEATHERED CLAYSTONE	120	125	0	20	0	15
	6	UNWEATHERED CLAYSTONE	125	130	600	30	600	30
	7	ENGINEERED FILL	130	135	200	35	200	35

1995 METCALF & EDDY REPORT SECTION C-C'

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0 25 50
SCALE IN FEET

GEOMETRIC CONDITION	ANALYSIS TYPE	GROUNDWATER CONDITION	MINIMUM SAFETY FACTOR		YIELD [3] ACCELERATION	MAXIMUM [4] SEISMIC DISPLACEMENT
			STATIC	0.06 g [2]		
EXISTING	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.4	0.8	0.01	N/A [5]
		100-YEAR WET YEAR	1.4	0.8	0.01	N/A [5]
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.5	0.9	0.02	10"
		100-YEAR WET YEAR	1.5	0.8	0.01	N/A [5]
18% REGRADE	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.7	0.9	0.04	5"
		100-YEAR WET YEAR	1.6	0.9	0.03	6"
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.7	0.9	0.04	5"
		100-YEAR WET YEAR	1.6	0.9	0.03	6"
18% REGRADE WITH BUTTRESS	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.8	1.0	0.06	3"
		100-YEAR WET YEAR	1.8	1.0	0.06	3"
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.9	1.0	0.06	3"
		100-YEAR WET YEAR	1.8	1.0	0.06	3"

[1] AVERAGE WET YEAR GROUNDWATER CONDITION, NOT SHOWN ON SECTIONS, IS 0 TO 2 FEET LOWER THAN 100-YEAR WET YEAR GROUNDWATER CONDITION.

[2] SEISMIC COEFFICIENT FOR PSEUDOSTATIC ANALYSIS.

[3] SEISMIC COEFFICIENT THAT PRODUCES SAFETY FACTOR OF 1.0 IN PSEUDOSTATIC ANALYSIS.

[4] ESTIMATED MAXIMUM SEISMICALLY INDUCED PERMANENT DISPLACEMENT USING SIMPLIFIED DEFORMATION ANALYSIS.

[5] PROCEDURE FOR ESTIMATING SEISMICALLY INDUCED PERMANENT DISPLACEMENT BECOMES INVALID, IN THIS CASE, FOR YIELD ACCELERATIONS OF 0.01 AND LESS. MAXIMUM DISPLACEMENT IN THIS CASE LIKELY GREATER THAN 12 INCHES.

E A R T H T E C H

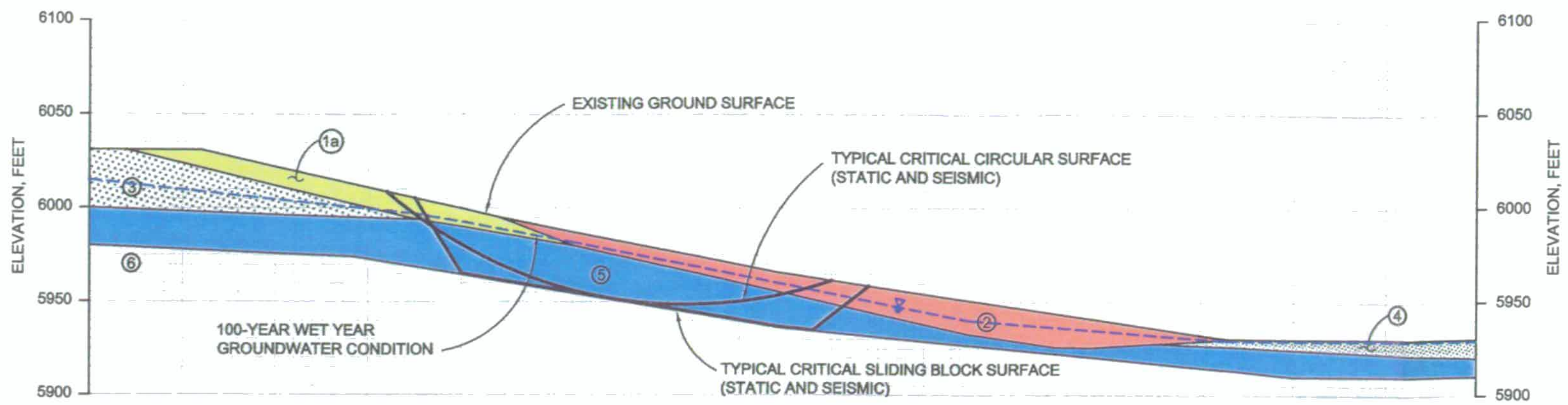
FIGURE 8

ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION STABILITY ANALYSES - M&E SECTION C-C'

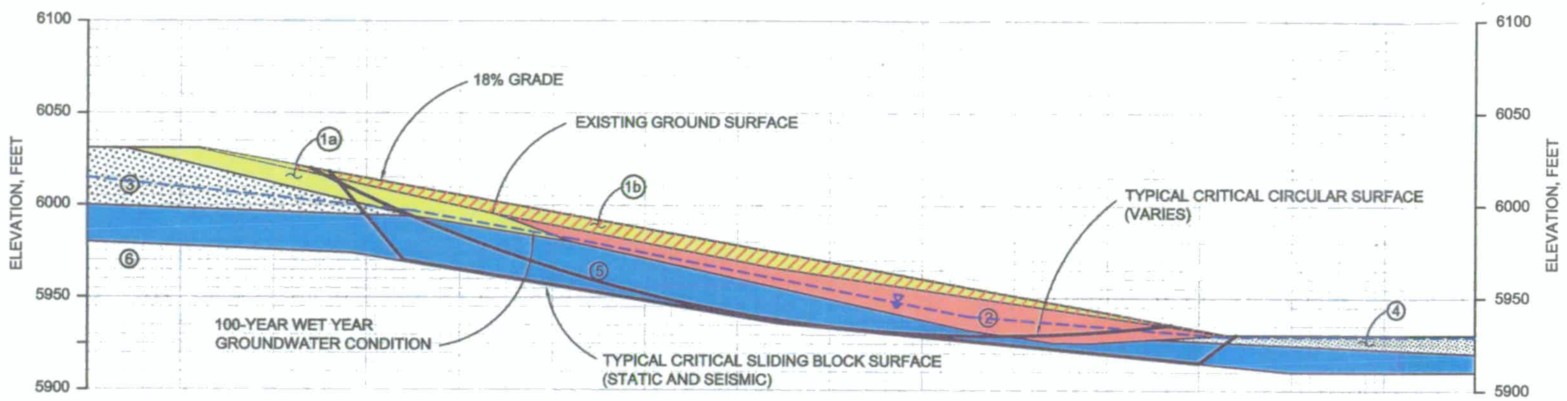
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

NOVEMBER 2004

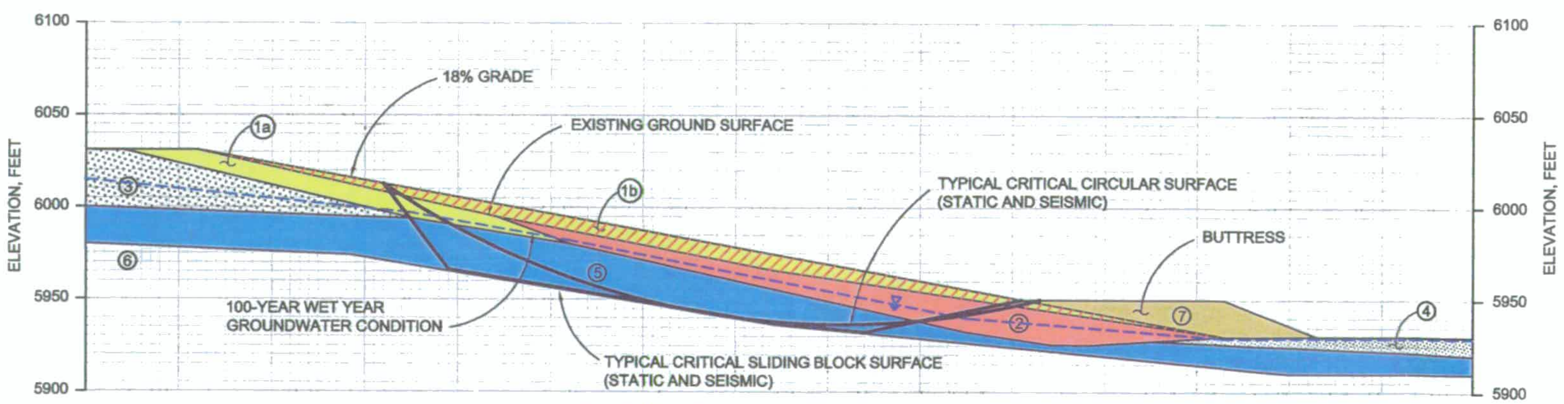
57378



EXISTING CONDITION



18% REGRADE CONDITION



18% REGRADE WITH BUTTRESS CONDITION

STABILITY ANALYSIS SOIL PARAMETERS

KEY	MATERIAL DESIGNATION	DESCRIPTION	UNIT WEIGHT		SHEAR STRENGTH			
					STATIC		SEISMIC	
			MOIST (pcf)	SATURATED (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
	1a	WASTE	120	125	50	30	50	30
	1b	WASTE / FILL / COVER	120	125	50	30	50	30
	2	COLLUVIUM / SLIDE	120	125	0	20	0	15
	3	ROCKY FLATS ALLUVIUM	120	125	0	37	200	30
	4	STREAM ALLUVIUM	125	130	0	33	0	33
	5	WEATHERED CLAYSTONE	120	125	0	20	0	15
	6	UNWEATHERED CLAYSTONE	125	130	600	30	600	30
	7	ENGINEERED FILL	130	135	200	35	200	35

1995 METCALF & EDDY REPORT SECTION D-D'

0 25 50
SCALE IN FEET

GEOMETRIC CONDITION	ANALYSIS TYPE	GROUNDWATER CONDITION	MINIMUM SAFETY FACTOR		YIELD [3] ACCELERATION	MAXIMUM [4] SEISMIC DISPLACEMENT
			STATIC	0.06 g [2]		
EXISTING	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.3	0.7	N/A [5]	N/A [6]
		100-YEAR WET YEAR	1.3	0.7	N/A [5]	N/A [6]
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.5	0.8	0.01	N/A [6]
		100-YEAR WET YEAR	1.4	0.8	0.01	N/A [6]
18% REGRADE	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.7	0.9	0.04	5"
		100-YEAR WET YEAR	1.6	0.9	0.03	6"
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.6	0.9	0.03	6"
		100-YEAR WET YEAR	1.6	0.9	0.02	10"
18% REGRADE WITH BUTTRESS	CIRCULAR SEARCH	AVERAGE [1] WET YEAR	1.7	1.0	0.05	4"
		100-YEAR WET YEAR	1.7	0.9	0.04	5"
	SLIDING BLOCK SEARCH	AVERAGE [1] WET YEAR	1.7	0.9	0.04	5"
		100-YEAR WET YEAR	1.7	0.9	0.04	5"

[1] AVERAGE WET YEAR GROUNDWATER CONDITION, NOT SHOWN ON SECTIONS, IS 0 TO 3 FEET LOWER THAN 100-YEAR WET YEAR GROUNDWATER CONDITION.

[2] SEISMIC COEFFICIENT FOR PSEUDOSTATIC ANALYSIS.

[3] SEISMIC COEFFICIENT THAT PRODUCES SAFETY FACTOR OF 1.0 IN PSEUDOSTATIC ANALYSIS.

[4] ESTIMATED MAXIMUM SEISMICALLY INDUCED PERMANENT DISPLACEMENT USING SIMPLIFIED DEFORMATION ANALYSIS.

[5] SAFETY FACTOR LESS THAN 1.0 FOR 0.0 g (STATIC CONDITION), USING ASSIGNED STRENGTH FOR SEISMIC CONDITION.

[6] PROCEDURE FOR ESTIMATING SEISMICALLY INDUCED PERMANENT DISPLACEMENT BECOMES INVALID, IN THIS CASE, FOR YIELD ACCELERATIONS OF 0.01 AND LESS. MAXIMUM DISPLACEMENT IN THIS CASE LIKELY GREATER THAN 12 INCHES.

EARTH TECH

FIGURE 9

ORIGINAL LANDFILL GEOTECHNICAL INVESTIGATION STABILITY ANALYSES - M&E SECTION D-D'

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

NOVEMBER 2004

57378

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APPENDIX A

BOREHOLE AND TEST PIT LOGS

TEST PIT LOGS

8/8

EARTH TECH

A tyco INTERNATIONAL LTD. COMPANY

TRENCH NO. TP-1 **LOCATION:** Rocky Flats Environmental Technology Site, Original Landfill

SHEET 1 **OF** 1 **NOTES:**

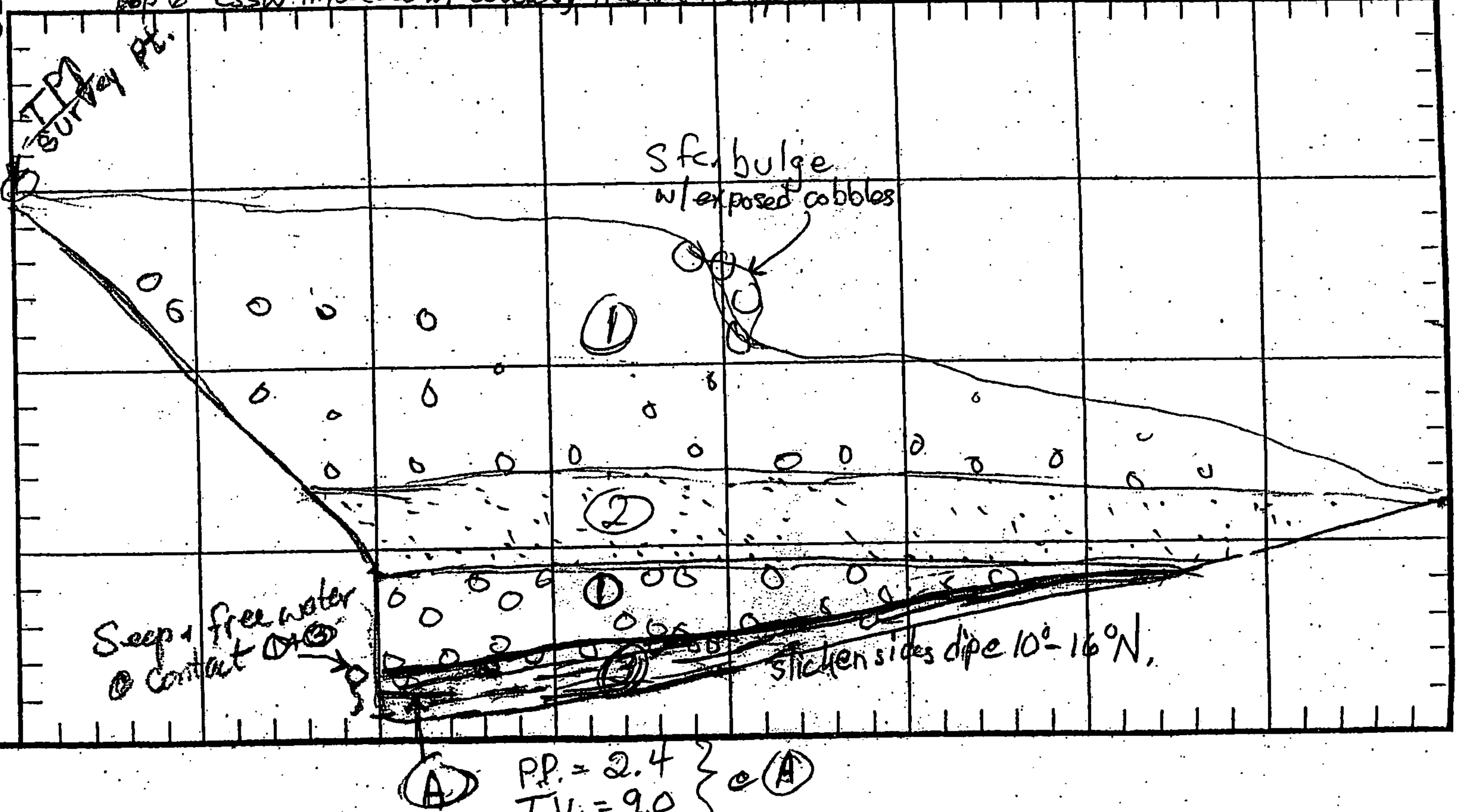
UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
0'-8.5' 11'-12.5'	1	COLLUVIUM (GW/SM) SANDY SILTY GRAVEL/ GRAVELY SILTY SAND; reddish brown 40% fn to med. sand; 40% fn + cse gravel + cobbles; 5.5'-8.5' becomes dk. brn, moist; free water + seeps @ contact w/ CSSW	A	TP1 L1-L4 Liner samples collected @ A aligned in E-W, @ 6" below GW + CSSW contact, massive slicks dipping 10°N. Liners driven w/ slide hammer		
8.5'-11.0'	2	ALLUVIUM? (SC) CLAYEY SAND; dk. brn.; ~ 60% fn + med. sand; 40% low plastic clay; moist; appears v. dense; tight + undisturbed.		L1 L2	L3 L4	N
12.5-14.5'	3	(CSSW) CLAYSTONE; med gray + reddish brown; sev. wthrd.; moist to wet; soft, plastic; numerous massive slickenside sfcs ~ 12"x18"; ~ 50% FeO2 stained, top 6" caliche deposits in veins + nodules top 6" CSSW imbedded w/ cobbles; free water @ top of contact.				

STATION ⟶

6/21/04

DATE

DEPTH (EL.)



R. Heidrich

LOGGED BY

1" 5'

SCALE, FT.

N.15°E.

BEARING

PROJECT NO. 57378

DATE

GRAPHIC TRENCH LOG

FIGURE NO.

8/8

TRENCH NO. TP-2 LOCATION: Rocky Flats Environmental Technology Site, Original Landfill

SHEET 1 OF 1 NOTES:

EARTH TECH

A tyco INTERNATIONAL LTD. COMPANY

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION COLLUVIUM	NO.	STRIKE	DIP	TYPE
0'–4'	1	Qc (CL) SANDY CLAY w/ GRAVEL; dk. brn.; 60% med. plstc clay; ~25% fn. sand; 15% fn. gravel moist. VALLEY FILL ALLUVIUM	No	Samples	Collected	
4'–6.5'	2	Qal (GW) SANDY GRAVEL; med. brn., 60% fn. to csa gravel, cobbles + boulders to 2'; 40% csa grained sand, wet, active seeps. BEDROCK				
6.5'–9'	3	CSSW (CL) CLAYSTONE, med. gray; sev. wthrd.; soft; plstc. wthrd to soil; moist; med plsty mottled w/ FeO2, carbon, + caliche, absence of slide plane or zone.				

STATION → TP-2 survey pt.

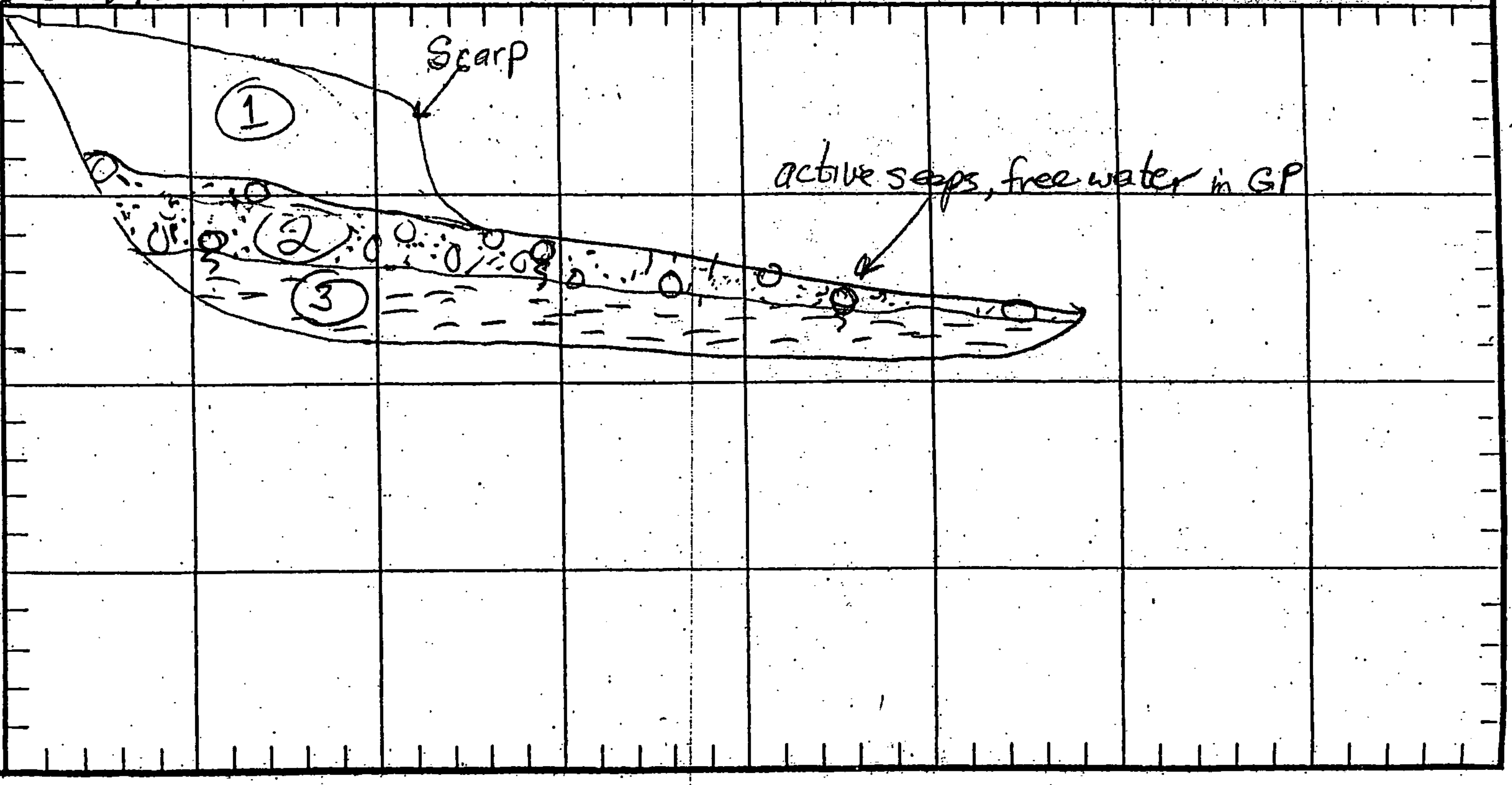
DEPTH (EL.)

6/24/04
DATE

R. Heidrick
LOGGED BY

1" 5'
SCALE, FT.

N, 10°E
BEARING



57378
PROJECT NO.

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

BOREHOLE LOGS

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT — FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 2

Borehole Number: B1
Location - North: / East:
Date: 6/30/04
Geologist: Rick Heidrick
Drilling Equip.:

Surface Elevation: ~6010
Area: Road
Total Depth: 38.0'
Company:
Project No.: 57378
Sample Type:

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE ______

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET
X-1	Run 1	2.6'/3.0'	C-1				Qf; GC	1–3
	Run 2	4.5'/5.0'					SC; SP/SM	4–8
X-2	Run 3	2.0'/2.0'						9–10
X-3	Run 4	2.0'/2.0'						11–12
X-3	DR	1.5'/1.5'		6, 14, 18				13
X-4	DR	1.5'/1.5'		12, 12, 11				14–15
	DR	1.3'/1.5	L1, L2, L3	5, 10, 10			CSSW	16
	P	2.3'/2.4'	S-1	250-500 psi			CSMW	17–19
X-5	Run 5	4.0'/4.0'	C-1					20

SAMPLE DESCRIPTION

Road Fill / Fill

0'-3.5' (GC) CLAYEY GRAVEL: med. brn.; 75% angular gravel + cobbles (crushed rock) to 6"; 25% med plstc clay (logged from cuttings) moist.
1.5'-3.5' less cobbles; pred fn + cse gravel; damp; reddish brn.

3.5'-5.0' (SC) CLAYEY SAND: lt. yellowish brn.; 80% fn + med sand; 20% low plstc clay; dry; med. dense

5.0'-15.7' (SP/SM) POORLY GRADED SAND / SILTY SAND: orange + white; 90% fine + med. sand; 10% silt; dry; pockets of FeOz, no bedding; imported fill; occ. fat clay.
10.0'-10.5' FAT CLAY; olive gray; med. to high plsty; moist; piece of CS in fill.
10.5'-15.5' wt sand (SP); med. dense, damp.

BEDROCK

15.7'-16.5' CLAYSTONE: SOV. wthrd.; pred. orange, some gray mottling; v. soft; plstc.; faint relict bedding + heavily FeOz stained in matrix; PP=3.3

16.5'-31' CLAYSTONE: mod. wthrd.; dk gray + orange; soft; friable to weak; mod FeOz staining along bedding planes; PP=5+; distinct bedding thinly laminated; FeOz on some bed sfc; intact.

NOTES: General: USCS is modified for this log as follows: *locally more intensely wthrd in wet zones, 21'-26' (over).
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

CSSW removed by grading / excavation activities?

14011-930-0134-930X Form CT.1A(03/01/97)

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 2 OF 2

Borehole Number: B1
Location - North: ______ East: ______
Date: ______
Geologist: ______
Drilling Equip.: ______

Surface Elevation: ______
Area: ______
Total Depth: ______
Company: ______
Sample Type: ______
Project No.: 57378

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE ______

water @ 21.9' on 7/14
interbedded/faulted w/sandstone @ 29.5'

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG	SAMPLE DESCRIPTION
X-5	Run 5	4.0'/4.0'	C-1				CSMW			black (manganese) deposits on bedding sfc's.
								21		21'-22' brecciated + FeO_2 stained.
								22		22' planar bedding @ 20°: 0-45°
								23		23.1'-23.7' frac's. wide to 3/4" infilled w/ manganese + carbon,
X-6	Run 6	4.7'/5.0'						24		FeO_2 filled, planar to irregular. wet zone.
								25		28'-26' intensely to closely frac'd. smooth frac sfc.
								26		25.5'-26.5' high angle frac. FeO_2 stained
								27		
								28		26.5'-29.5'; CS slightly wthrd.
X-7	Run 7	5.0'/5.0'						29		
								30	SS	29.5'-31' SANDY SILTSTONE: lt. yellowish brn.;
							CSUW	31	CSUW	mod. wthrd.; soft; weak; moist; thinly laminated beds dipping 80°; FeO_2 stained
								32		bedding SS interbedded w/ clayey sand; parallel bedd not sheared
								33		31'-38' CLAYSTONE; unweathered;
X-6	Run 8	5.0'/5.0						34		dk gray; soft; weak to mod. strong; closely frac'd:
								35		31.5' frac, 15°, healed, no infilling, planar; smooth sfc, in claystone
								36		31.5'-32' brecciated CS
								37		locally crushed; no FeO_2 stains; occ. frac's 55°-70°; sub horz. bedding thinly lamin.
								38		34.5'-36': crushed;
								39		BOH @ 1430 GW @ 32' @ 1450
								40		Backfilled to sfc. w/ bentonite chips

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision: 0
Date effective: 12/31/98

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

U-16 B2a 0' B2

PAGE 1 OF 2

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B2
Location - North: East:
Date: 7/6 + 7/7
Geologist: Rick Heidrick
Drilling Equip.: All terrain CME-75

Surface Elevation:
Area:
Total Depth: 25.0'
Company:
Project No.: 57378
Sample Type:

RMRS LOGGING SUPERVISOR APPROVAL

DATE Dry to 15' 7/14

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION FILL
X-1a	Run 1	4.5/5.0	C-1				Qf	1–5	0 0	0'-6.5' SANDY CLAY w/ GRAVEL: (CL) med. brn., some orange; 60% med plstc clay; 25% fn. sand; 15% fn + cse gravel to 4"; moist; stiff; 3' PP=5+ 5' PP=2.7
	DR	1.0/1.5	L1 L2	6 6 6 6				6	0	BEDROCK
X-2a	Run 2	3.5/5.0	C1		P 2.3/2.4	S-1	CSSW, CSMW	7–9		6.5'-8' CLAYSTONE; orange; sev. wthrd; to soil; v. soft; plastic; no bedding; soil-like; med. plsty; 10% fn sand; FeO2 stained throughout
X-3	Run 3				P 2.4/2.4	S-2		10–11		8'-17.5' CLAYSTONE: med. gray; mod. wthrd. localized FeO2 stains; soft; friable; thinly laminated; near horizontal, 20°; caliche nodules; v. stiff PP=3.6 carbonaceous; crushed - intensely frac'd.; some FeO2 on frac. sfcs.; vert fracs.
X-4	DR	1.3/1.5	L3 L4 L5	6 14 24	C 3/3			12–13		
	Run 4	1.5/1.5	C-1					14–15		
	Run 5	5.0/5.0	C-1					16–17		17.5'-25.0' CLAYSTONE; v. dk. gray; unwthrd; soft to mod. hard; weak to strong; dry; no FeO2 stains.
X-5							CSUW	18–20		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

(4011-930-0134-930)(Form GT.1A)(03/01/97)

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B2
Location - North: ______ East: ______
Date: ______
Geologist: ______
Drilling Equip.: ______
Surface Elevation: ______
Area: ______
Total Depth: ______
Company: ______
Project No.: 57378
Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE ______

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
X-5	Run 6	5.0/5.0	C-1					21	CSUW	CLAYSTONE (cont,)
								22		
X-6								23		
								24		
								25		
								26		Backfilled w/ bentonite chips
								27		
								28		
								29		
								30		
								31		
								32		
								33		
								34		
								35		
								36		
								37		
								38		
								39		
								40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B3
Location - North: ________ East: ________
Date: ________
Geologist: Rick Heidrick
Drilling Equip.: ________

Surface Elevation: ________
Area: ________
Total Depth: 34'
Company: ________ Project No.: 57378
Sample Type: ________

RMRS LOGGING SUPERVISOR
APPROVAL ________ DATE ________

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG	SAMPLE DESCRIPTION
										Road Fill
X-1	Run 1	4.0'/4.0'	C-1				Qf	1, 2, 3, 4		0'–13' (CL) GRAVELLY SANDY CLAY; varies dk. brn. to yellowish brn; 50% med-plstc clay; 25% fn to cse sand; 25% fn to cse gravel to 3"; damp; angular gravel/crushed rock; varies w/ depth to → SANDY CLAYEY GRAVEL
	DR	0.7'/1.5	L-1	15 16 10				5		CL olive gray mottled orange; 30% med. plstc. clay 20% fn-med-sand; 50% cse gravel to 3"
X-2	Run 2	3.5'/3.5'	C-1					6, 7, 8		
	P	2.0'/2.0'	S-1	150 250 500	C-1			9, 10		10' shelby refusal; 3" rock @ 10.0'
X-3	DR	0.2'/1.5'		6 12 13				11		COLLUVIUM
	DR	NR		7 9 13				12, 13		13'–16' (CL) LEAN CLAY w/ GRAVEL; orange; 60% med. to high plstc clay; 20% fn-cse gravel to 4"; rounded; 20% fn to cse sand PP=1.8 TV=6
X-4	DR	NR		10 10 10			Qc	14		15' becomes mottled grey
	Run 3		C-1					15		BEDROCK
	DR	1.3'/1.5	L-2 L-3 L-4	2 6 7				16		
	DR	1.2'/1.5	L-5 L-6 L-7	8 13 15			CSSN CSMW	17, 18		16'–17.5' CL CLAYSTONE; med. gray; sev. wthrd. to soil; v. soft & plstc; soil-like: FAT CLAY, high plstc
X-5	P	2.2'/2.4'	S-2	200 500				19, 20		v. stiff; moist; PP=2.2 TV=>10 FeO2 stained, sltly. carbonaceous.

over

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 2 OF 2

Borehole Number: B3

Location - North: ______ East: ______

Date: ______

Geologist: ______

Drilling Equip.: ______

Surface Elevation: ______

Area: ______

Total Depth: ______

Company: ______

Project No.: 57378

Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE Dry to 28' 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
P			32						CSW	17.5'-25.5' CLAYSTONE: crushed w/ hard angular clay pieces in clay matrix brecciated; matrix FeO2 stained. 20.5': PP>5; occ. slks, rare carbon; mod. wthrd.; little FeO2 no bedding; frac. sfcs FeO2 stained. 22' PP=3.0 24' PP>5
X-5 / X-6	Run 4	3.5'/3.5	C-1					21, 22, 23, 24		
	DR	1.3'/1.5	13 30 47	L-8 L-9 L-10				25		24-25.5' CLAYSTONE w/ SANDSTONE
X-6 / X-7	Run 5	3.5'/3.5	C-1				CSW	26, 27, 28, 29		25.5'-34' CLAYSTONE: V. dk. gray; unweathered; soft; weak; crushed; disturbed; rare FeO2 stain; thinly laminated @ 10° dip.
	Run 6	5.0'/5.0'						30, 31, 32, 33, 34		26.5'-29.5' brecciated. 30' rig chatter. 29'-30' locally mod. wthrd.
								35, 36, 37, 38, 39, 40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B4
Location - North: East:
Date: 6/24 + 6/25
Geologist: Rich Heidrich
Drilling Equip.: CME-75

Surface Elevation: ~5975
Area:
Total Depth: 34.0'
Company: Layne Project No.: 57378
Sample Type: SPT, Cal.Mod, Shelby, Core

RMRS LOGGING SUPERVISOR APPROVAL ____ DATE ____

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
							Qf			Road Fill
X-1	Run 1	3.7/4.0'	C-1					1–4		0'–8.5' (GC) SANDY CLAYEY GRAVEL w/cobbles; reddish brown to dark brown; fn + cse gravel + cobbles to 8"; 80% med plstc. clay; 20% fn + cse sand.
X-2	Run 2	5.0'/5.0						5–8		COLLUVIUM
							Qc	8–9		8.5'–14'? (CL) SANDY CLAY; dk. brn.; 70% med. plstc clay; 30% fn. sand; rare fn. gravel; moist; stiff; pp = 1.75 mixed w/ pieces of CSSW claystone/lean clay
X-?	DR	8 / 6 / 9	L1 / L2 / L3					9–10		LEAN CLAY; med. plstc; caliche nodules sev. wthrd claystone in Qc
	P	1.2'/1.2'	S1	100 250 psi				11–12		
	P	2.0'/2.5	S2	250 400				12–14		BEDROCK
							CSSW	14		14'?–17 CSSW CLAYSTONE; med. gray; sev. wthrd. v. soft; plstc; wthred to clay; extensively FeO2 stained; pp = 2.3; v. stiff; some caliche nodules; slks @ 18
	P	2.0'/2.5	S3	100 250 400				15–16		
							CSMW	17		17'–29' CLAYSTONE: mod. wthrd; locally crushed w/ slicks + heavy FeO2 stains; intensely frac'd. + laminated bedding w/ depth.
X-3	Run 3	2.0'/2.0	C-1					18–19		
	DR	1.4/1.5	L4 / L5	9/12		9 / 12		20		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B4
Location - North: ________ East: ________
Date: ________
Geologist: ________
Drilling Equip.: ________

Surface Elevation: ________
Area: ________
Total Depth: ________
Company: ________ Project No.: 57378
Sample Type: ________

RMRS LOGGING SUPERVISOR APPROVAL ________ DATE ________

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG	SAMPLE DESCRIPTION
	DR		L6	25					CS MW	
X-3	C	3.5' / 3.5'	C-1					21		22' closely frac'd; frac sfcs heavily FeOx stained; soft; weak; PP=4.5
								22		
22.5'										
X-4								23		
								24		24' becomes thinly laminated; soft; weak to mod. strong; minor FeOx stains on frac. planes.
		5.0' / 5.0'						25		
								26		
								27		
X-5								28		
								29	CS UW	29'-34' CSUW CLAYSTONE; med. gray; unweathered soft; weak; no FeOx; ~10% carbonaceous deposits; horiz. laminated to thinly laminated
		5.0' / 5.0'						30		
								31		
X-6								32		
								33		
								34		Backfilled w/ bentonite chips
								35		
								36		
								37		
								38		
								39		
								40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B4A
Location - North: ________ East: ________
Date: 6/23/04
Geologist: Rick Heidrick
Drilling Equip.: CME-75

Surface Elevation: ~5975
Area: RF OLF
Total Depth: 33.5
Company: Enyne Project No.: 57378
Sample Type: Continuous Core 5'x3"

RMRS LOGGING SUPERVISOR APPROVAL ________ DATE 6/23/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG	SAMPLE DESCRIPTION
										Advance boring using 8" hollow stem augers. Continuous core sampling using 5'×3½ Sample barrel advanced ahead of auger bit. Road Fill
							Qf			0'-9' GC SANDY CLAYEY GRAVEL w/COBBLES dark brown; 50% gravel + cobbles to 6"; rounded; 25% med. plstc clay; 25% fn. sand appears med. dense; moist; appears derived from Rocky Flats Alluvium.
X-1	Run 1	1.2' 2.8' / 4.0'						1		
								2		
								3		
		NR						4		
	Run 2	2.5'/2.5'	C1					5		
								6		
NR	Run 3	0.5'/2.5'	No liner					7		~9' cuttings of SC/CL
								8		COLLUVIUM
X-2							Qc	9		9'-16'. Qc SANDY CLAY; dk brn; ~70% med. plstc clay ~30% fn to cse sand; moist; appears firm.
	Run 4	0.5'/2.5'						10		
								11		
	Run 5	0.5'/2.5'						12		9'-14' Soil in core barrel is in form of clay shavings, possible cobble loged in auger bit, Pull augers, No obstruction. Enter hole + drive cal Mod
								13		
	Run 6	1.0'/2.5'						14		
								15		BEDROCK
X-3	Run 7	2.0'/2.5'					CSW	16	CSW	16'-18' CLAYSTONE; med gry; sev. wthed; extensive FeO₂ staining in matrix; stiff; v. soft; plastic; pp= 6 e 16.2'; moist; crushed & intensely frac'd.
								17		
							CSMW	18	CSMW	18'-30', becomes MW, less FeO₂; intensely to closely fraced; smooth frac sfcs. ~~soft, friable damp.~~
	DR CM 27 27 33	1.5'/1.5						19		
								20		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B4A
Location - North: ______ East: ______
Date: 6/23/04
Geologist: R.H.
Drilling Equip.: ______

Surface Elevation: ______
Area: ______
Total Depth: 33.5
Company: ______ Project No.: 57378
Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE Moist @ 23' 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG	SAMPLE DESCRIPTION
X4	DR	50 50/2	NR					21	CS SW	CSww cont. 20.5' less FeO2; deposited as small (~3mm) nodule & vert fracs. sfcs. 8"
	HA							22		Augered to 22' w/ core barrel; recovered rock in core.
	DR SPT	10 23 29	1.4'/1.5'					23		
	Run 8	2.8'/2.5' *						24		25' heavy FeO2 in 70° joint sfc.
								25		26' Mod. frac'd, subvert. joints w/ heavy FeO2; laminated w/ fn grained sandstone; claystone bedding laminated to thinly laminated.
								26		
X-5	Run 9	3.5'/2.5' *						27		
								28		
X6		3.0'/5.0'	w/ acrylic liner					29		
								30		30'-33.5' CLAYSTONE; unweathered;
	Run 10							31	CS UW	dark gray; soft; weak; mod. frac'd. @ high angles; absence of FeO2; laminated bedding present; some carbon layers; dry.
								32		
								33		acrylic liner crushed in core barrel @ 3' blocking clay from full recovery.
								34		Dry @ completion of boring @ 1415.
								35		
								36		
								37		
								38		
								39		
								40		

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Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

* clay expands in core barrel ~ 50%

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 3

Borehole Number: B5

Location - North: ______ East: ______

Date: 6/28/04

Geologist: Rick Heidrick

Drilling Equip.: CME-75

Surface Elevation: ~ 5,970

Area: ______

Total Depth: 42.0'

Company: ______

Project No.: 57378

Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE ______

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
										FILL
X-1	Run 1	3.0'/4.0'	C-1				Qf	1	CL	0'-10.5' (CL) GRAVELLY CLAY med. brn.; ~50% med. plstc. clay fn. to cse. gravel; mixed w/ clayey sand ~~+ sandy clay~~ moist to damp
								2		
								3		
								4		
	Run 2	3.5'/5.0'						5		
								6		
X-2								7		
								8		
								9		
	Run 3	3.4'/5.0'						10		COLLUVIUM
							Qc	11	Qc	10.5'-37' (CL/GC) GRAVELLY SANDY CLAY, reddish brn.; gray + yellowish brn.; ~40% med. plstc. clay ~30% fn. to cse. gravel; ~30% fn. to cse sand; percent varies w/ depth; moist; lean clay w/ gravelly lenses + clayey sand lenses, mixed w/ depth, some clayey gravel.
								12		
X-3								13		
								14		
	DR	1.3'/1.5'	L1 L2 L3	3 5 6				15		12.5'-13.5' clayey sand w/ gravel
								16		
X-3	Run 4	3.5'/3.5		C-1				17		no slide planes or zones
								18		
								19		
X-4	Run 5							20		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

(4011-930-0134-930)(Form GT.1A)(03/01/97)

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B5
Location - North: ________ East: ________
Date: ________
Geologist: ________
Drilling Equip.: ________

Surface Elevation: ________
Area: ________
Total Depth: ________
Company: ________ Project No.: 57378
Sample Type: ________

RMRS LOGGING SUPERVISOR APPROVAL ________ DATE Moist @ 31' 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
X-4	Run 5	2.5' / 3.0	C-1				Qe	21 22		20.5'-24' GRAVELLY CLAY; med. plsty. wet.
	P	2.1' / 2.3'	S-1	100-400 psi				23 24		24'-25' Tube darted, gravelly.
	P	1.9' / 2.3'	S-2	100-400				25 26		25'-27' sandy clay w/ gravel FeO2 stained
	DR	1.5' / 1.5'	L4 L5 L6	4 7 11				27 28		27' FeO2 stained
	P	1.0' / 2.5	S3	500 psi				29 30		29'-30.5' CLAYEY GRAVEL
X-4 X-5	Run 6	3.5' / 3.5	C-1		B5a 30 50/3" 50/3"	L-1 L-2 NR		31 32 33		BEDROCK
	DR	NR	NR	50/6"	HA	HA	CSMW	34	CSMW	37'-38' CLAYSTONE: yellowish brn. w/ red + wt. mottling; mod. wthrd.; soft friable; no slide planes/zones.
X-5	Run 7	0.5' / 1.5	C-1		100/4"	NR		35 36		
	DR	NR		150/6"						
	DR	NR		200/5"	150	6"	NR	37		
	HA				30 100/4	0.7 / 0.7	L3 L4	38		38'-42' CLAYSTONE; dk. gray; fresh; soft; friable; thinly laminated; dry; intact + in place.
	DR	0.4' / 0.7	L7	41 50/3"				39 40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

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U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE ~~2~~ 3 OF 3

Borehole Number: B5
Location - North: East:
Date:
Geologist:
Drilling Equip.:

Surface Elevation:
Area:
Total Depth:
Company: Project No.: 57378
Sample Type:

RMRS LOGGING SUPERVISOR APPROVAL

DATE

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
X-5	Run 8	2.5'/2.5'	C-1				CSLW	41		"40'-42' becomes laminated.
								42		
								43		
								44		
								45		
								46		
								47		
								48		
								49		
								~~9~~ 50		
								11		
								12		
								13		
								14		
								15		
								16		
								17		
								18		
								19		
								20		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

(4011-930-0134-930)(Form GT.1A)(03/01/92)

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B6
Location - North: ___ East: ___
Date: 7/9/04
Geologist: Rick Heidrich
Drilling Equip.: CME-75

Surface Elevation: ___
Area: S. of Road
Total Depth: ___
Company: ___
Project No.: 57378
Sample Type: ___

RMRS LOGGING SUPERVISOR APPROVAL ___ DATE ___

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET
X-1	Run 1	3.0/4.0	C-1				Qf	1–4
	DR	NR	-	5 6 9				5
X-1	DR	NR		5 5 9			Qc	6–7
X-2	Run 2		C-1					8
X	DR	1.0/1.5	L-1 L-2	4 5 6				9
X-2	Run 3	1.5/1.5	C-1					10–11
X-3	P	1.1/2.4	S-1	0 50			CSSW	12–13
	DR	1.4/1.5	L-3 L-4 L-5	4 7 10			CSHW	14–15
X-3	Run 4	4.0/4.0	C-1					16–17
X-4								18–19
	DR	1.4/1.5	L-6 L-7	8 16				20

SAMPLE DESCRIPTION

Road Fill

0-5', SANDY CLAY w/ GRAVEL: lt. to dk. brn.; 70% med plstc clay; 20% fn. sand, 10% crse. gravel, angular; stiff.

COLLUVIUM

5'-11' LEAN CLAY w/ GRAVEL; v. dk brn. 70% med. to high plstc. clay; 20% fn + cse gravel to 5; rounded; moist stiff; 10% fn. sand PP = 0.7 + 1.3 TV = 5.2. gravelly layers

BEDROCK

11'-14.0' CLAYSTONE: med. gray w/ orange; sev. wthrd to soil; v. soft; plstc.; soil-like Lean clay w/ sand; moist; v. stiff; PP = 2.1; locally FeO2 stained throughout. PP>2.

14.0'-33.0' CLAYSTONE; med. gray w/ some orange; mod. wthrd.; soft; friable to weak; locally crushed cg in clay matrix

17.5'-18; 40° shear sev. wthrd.; slks; gravel concrete

NOTES: General: USCS is modified for this log as follows: 18'-18.5' crushed.
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

(4011-430-0134-930)(Form GT.1A)(03/01/93)

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

PAGE 2 OF 2

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B-6
Location - North: East:
Date:
Geologist:
Drilling Equip.:
Surface Elevation:
Area:
Total Depth:
Company:
Project No.: 57378
Sample Type:

RMRS LOGGING SUPERVISOR APPROVAL

DATE Dry to 31' 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
	DR		L-8	26						vert. fracs FeOz coated, PP>5
X-5	Run 5	3.5'/3.5'	C-1					21		
								22		crushed
								23		23'-24' extensively FeOz stained
								24		24' horz. bedding; vert. fracs FeOz filled.
X-6	Run 6	2.5'/2.5'	C-1					25		
								26		
	DR	0.8'/1.0	L-9 L-10	20 50/6"				27		28' SS/CS
	Run 7	1.5'/1.5	C-1					28		
								29		
X-7	Run 8	5.0'/5.0	C-1					30		
								31		
								32		
							CSUW	33		33'-38' CLAYSTONE: v. dk gray; fresh; mod. hard; weak to mod strong; horiz. thinly laminated bedding; no FeOz stains.
								34		
X-8	Run 9		C-1					35		
								36		
								37		
								38		Backfilled w/ bentonite chips.
								39		
								40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 2

Borehole Number: B7
Location - North: ______ East: ______
Date: 6/29/04
Geologist: Rick Heldrich
Drilling Equip.: CME-75

Surface Elevation: ______
Area: RFOLF
Total Depth: 36.5'
Company: ______ Project No.: 57378
Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______

DATE GW @ 10.9' on 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
										Road Fill
X1	Run 1	4.0/4.0	C-1				QF	1, 2, 3	CL	0'-3' (CL) GRAVELLY SANDY CLAY: med gray ~60% med. plstc clay; ~20% fn+cse gravel; ~20% fn+med. sand; moist.
X-2	Run 2	2.6/4.0						4, 5, 6	GC	3'-6' (GC) CLAYEY SANDY GRAVEL: lt. brn; 60% fn+cse gravel 20% sand+clay; damp. COLLUVIUM
	DR	1.5/1.5	L1 L2 L3	2 4 4			Qc	7, 8, 9	Qc / Qc	6'-11.5' (CL) LEAN CLAY w/ SAND: olive to dk. brn; 80% med. plstc clay; 20% occ sand lenses randomly oriented; moist; stiff (PP=1.8); gravelly @ depth. 8'-11.5' becomes SANDY CLAY w/ GRAVEL (CL): dk. brn; 60% med. plstc clay; 20% rounded fn. gravel; 20% fn to cse sand; moist
X-2	Run 3	2.0/2.0	C-1					10, 11		9.5'-11.5' ~10% fn. gravel; 11' PP= 1.3
	DR	1.5/1.5	L4 L5 L6	3 4 6			CSSW	12, 13	CSSW	BEDROCK 11.5'-17.5' CLAYSTONE; olive gray, mottled lt. + reddish brn.; sev. wthrd. to resid. soil; v. soft; plstc.; soil like qualities - LEAN CLAY w/ SAND; 90% med. plstc clay; 10% fn. sand; FeOx stains in veins, caliche nodules; v. moist; rare gravel (1%?) firm (PP = 0.9)
	R	2.0/2.0	S-1	150 psi				14, 15		
X-3	Run 4	2.0/2.0	C-1					16, 17		15.5' PP= 1.7
	DR	1.5/1.5	L7 L8 L9	4 8 13			CSHW	18, 19		17.5' PP= 1.0 CLAYSTONE; mod. wthrd.; 17.5'-39' grey little FeOx, no caliche; failure zone 17.5' - dry; soft; friable; brecciated; crumples to ~1/2-1/4" angular pieces; locally FeOx stains.
	DR	1.4/1.5	L10 L11	5 13				20		

bag core in barrel

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

4011-430-0134-930 (Form GT.1A)(03/01/97)

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B7
Location - North: ______ East: ______
Date: ______
Geologist: ______
Drilling Equip.: ______

Surface Elevation: ______
Area: ______
Total Depth: 36.5'
Company: ______
Project No.: 57378
Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE ______

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/ LITHOLOGIC LOG	SAMPLE DESCRIPTION
	DR		L12	27			CSMW			20-20.5' locally FeOz stained intensely frac'd.; sub horiz bedding FeOz stain bedding planes; mostly orange; some gray; locally crushed.
X-3	Run 5	3.5'/3.5'	C-1					21		
								22		
								23		20.5'-21.5' V. soft to soft pp=0.2 mechanically disturbed from over drilling called' mixed w/ gravel.
X-4								24		
	Run 6	5.0'/5.0'						25		21.5'-23' crushed
								26		
								27		24'-26' subvert. frac. FeOz filled; water conduit. 24' becomes mod. frac'd, locally crushed; smooth sfcs / slks on fracs.
								28		
X-5								29		27' pp+5
	Run 7	2.5'/2.5'						30		28.5' - minor FeOz
								31		
	DR	1.3'/1.5'	L13 L14 L15	10 36 42				32		
								33		33'-36.5' CLAYSTONE; dk gray; slightly wthrd.; soft to mod. hard; weak to mod. strong; mod frac'd.; laminated; dry; occ rare sandstone beds.
X-6	Run 8						CSUW	34		
								35		
								36		36'-36.5' FeOz stained
								37		Backfilled w/ bentonite chips.
								38		
								39		
								40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

B8a 0'-4.5' B8b 0'-17' B8c 0'-25

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF ___

Borehole Number: B8b&c
Location - North: / East:
Date: 7/1/04
Geologist: Rick Heldrick
Drilling Equip.: CME75 All Terrain Rig

Surface Elevation: ~5950
Area: Woman Creek
Total Depth: 25'
Company:
Project No.: 57378
Sample Type:

RMRS LOGGING SUPERVISOR APPROVAL ___ DATE G.W. @ 9.2' on 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION COLLUVIUM Qc Qls
X-1	Run 1	4.5/5	C-1				Qls / Qc	1		0'-1.5' (CL) LEAN CLAY; med brn; 90% med plstc clay; 10% fn. sand; moist; stiff pp-1¼
								2		1.5'-8.0' SANDY CLAY w/ GRAVEL:
	B8b							3		(CL) med brn; 50% med plstc clay; 30% fn+cse gravel to 3"; 20% fn+cse sand; damp; occ cobbles + boulders.
								4		
						B8c		5		
X-2	Run 2	3.5/5.0	B8C 7'-10' Core Box	P	2.2/2.4	S1 300		6		slide zone? 6'-8' LEAN CLAY; med. gray; 90% med plstc clay; 10% fn sand locally FeOx stained moist; v. stiff, TV=8 PP=2.3 tsf
								7		
						500		8		dep. contact? slide zone? slide zone contact?
						Qa	Qa	9		ALLUVIUM 8.0'-14.5' SANDY CLAYEY GRAVEL; dk brn; 50% rounded fn-cse gravel; 30% high plstc clay; 20% fn to cse sand; wet; med dense, 9'-10' PP=0.7; TV=2.0
								10		
	DR	9.5/1.5	L1	10 8 10				11		
	DR	0.5/1.0	L2	21 50/5				12		13'- 60% gravel 20% sand, 20% clay
X-3	Run 3	1.5/1.5	C-1		B8c			13		
								14		BEDROCK No slide plane
	DR	0.6/1.5	L3	12 12 19	DR 5/8	NR	CSGW	15		14.5-18' CLAYSTONE, med gray w/ orange wt. calcite mottling; v. soft to soft; plstc to friable; crushed pieces in soft clay matrix; soil-like → v. stiff med-high plsty PP=2.4 moist to wet
	DR	NR		29 30 38	2.1/2.4	S2 P 600 psi		16		
								17		
								18		
B8C X-2	Run 4				C-1	2.0/2.0'	CSHW	19		18'-22' CLAYSTONE; dk gray w/ some orange; mod. wthrd; soft; weak; FeOx on frac. surfaces, laminated bedding - intensely fract. in places
								20		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

14011-930-0134-930X Form GT.1A (03/01/92)

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 2 OF 2

Borehole Number: B8
Location - North: ________ East: ________
Date: ________
Geologist: ________
Drilling Equip.: ________
Surface Elevation: ________
Area: ________
Total Depth: ________
Company: ________
Project No.: 57378
Sample Type: ________

RMRS LOGGING SUPERVISOR
APPROVAL ________ DATE ________

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/ LITHOLOGIC LOG	SAMPLE DESCRIPTION
B8C X-3	Run 5	5.0/5.0'	C-1				CSMW		CSMW	20-22' FeO2 staind thruout matrix.
								21		
							CSUW	22	CSUW	22'-25' CLAYSTONE; dk gray; fresh/unweathered; no discoloration; soft to mod. hard; weak to mod. strong; thinly laminated @ 20°; siltly carbonaceous; in place; little frac'd.
								23		
								24		
								25		Backfilled w/ bentonite chips.
								26		
								27		
								28		
								29		
								30		
								31		
								32		
								33		
								34		
								35		
								36		
								37		
								38		
								39		
								40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B-9 (B9a offset)
Location - North: East:
Date: 7/6/04 + 7/7
Geologist: Rick Heidrick
Drilling Equip.: All Terrain CME-75

Surface Elevation: ~5950
Area: Woman Creek
Total Depth: 25'
Company:
Project No.: 57378
Sample Type:

RMRS LOGGING SUPERVISOR APPROVAL

DATE GW@ 4.4' on 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG
X-1	Run 1	5.0' / 5.0'	C-1	C	B9a		Qa	1	
				P 0 psi	St	1.5' / 2.4'		2, 3	
				DR	L-1, L-2, L-3	2, 4, 7	1.3' / 1.5'	4, 5	
X-2	DR	1.2' / 1.5'	L-1, L-2, L-3	2, 6, 23				6	
	C	1.0 / 1.5	L4, L5	26, 6, 12			CSSW	7, 8	CSSW
	DR	1.3 / 1.5	L-6, L-7, L-8	18, 9, 13				9	
	P	1.5' / 1.5	S-1	300, 500, 600 psi				10, 11	
X-3	Run 2	4.0' / 4.0'	C-1				CSMW	12, 13, 14, 15	CSMW
X-4	Run 3	5.0' / 5.0'	C-1					16, 17, 18, 19, 20	

SAMPLE DESCRIPTION

ALLUVIUM

0'-6.7' SANDY LEAN CLAY; v. dk brn.; ~70% med. plstc clay; 30% fn to csc sand; moist; firm; PP=0.5-1.0 TV=4.0. Wet@4.5'; occ. rounded gravel to 1½". (CL)

6' becomes gravelly; 50% clay; 30% sand; 20% fn. gravel.

BEDROCK

6.7'-11' CLAYSTONE; med. gray; sev. wthrd to residual soil; v. soft; caliche nodules; plstc.; no bedding. Soil-like lean to Fat Clay w/ sand: PP=2.2, 1.5; TV=7.0

9' becomes crushed in clay matrix. PP=1.5 TV=7

11 Shelby refusal.

11'-15' Some slks on frac sfc's; water on frac sfcs

11'-23' CLAYSTONE; med. gray; mod. wthrd; soft; weak; faint thinly laminated 20° bedding; crushed pieces in clay matrix; some slks on frac. sfc's. wet on frac. sfc's. PP=5+. Some FeO2 stains on vert. frac's. Some carbon

NOTES: General: USCS is modified for this log as follows:
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(1) Badly broken core, accurate footage measurements not possible.
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U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

PAGE 2 OF 2

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B9
Location - North: ______ East: ______
Date: 7/7/04
Geologist: ______
Drilling Equip.: ______

Surface Elevation: ______
Area: ______
Total Depth: ______
Company: ______ Project No.: 57378
Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE ______

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
									CSMW	
X-5	Run 4	4.5' / 5.0'	C-1					21		
								22		
								23	CSUW	23'-25' CLAYSTONE; black; unweathered; soft to mod. hard; mod. strong; thinly laminated; in place.
								24		
								25		
								26		
								27		
								28		
								29		
								30		
								31		
								32		
								33		
								34		
								35		
								36		
								37		
								38		
								39		
								40		

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Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
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Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B10
Location - North: ______ East: ______
Date: 7/7/04
Geologist: Rick Heidrick
Drilling Equip.: CME-75

Surface Elevation: ______
Area: ______
Total Depth: 34'
Company: ______
Project No.: 57378
Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______

DATE G.W. @ 19.0' on 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG	SAMPLE DESCRIPTION
										Waste Fill
X-1	Run 1	2.0'/4.0'	C-1				Qf	1		0'-4' (CL) SANDY GRAVELLY CLAY; dk. to lt. brn. varies; ~40% med. plstc clay; 30% fn-med sand; 30% fn+csg gravel to 4"; moist;
								2		
								3		metal chards @ 1.5'.
								4		COLLUVIUM
	DR	1.4/1.5	L-1 L-2 L-3	4 14 15			Qc	5		4'-6' LEAN CLAY w/ SAND; med. brn.; 80% med to high plstc clay; 10% fn. sand; 10% rounded gravel to 1"; damp PP = 4.5; hard; gravel layer 5.5'-6.0'
X-1	Run 2	3.5/3.5	C-1				CSMW	6		
								7		
X-2								8		BEDROCK
								9		6'-26.5' CLAYSTONE; med brn to orange; Mod. wthrd.; FeO2 stained in clay matrix soft; weak; crushed pieces in clay matrix
	DR	1.2/1.5	L4 L5 L6	14 18 22				10		6.5'-7.0'; 60° frac/shear plane, flat to wavy w/ slks, healed; shear zone 6'-9'?
X-2	Run 3	3.5/3.5	C-1					11		occ. fn gravel in CSMW; 7-9' crushed.
								12		PP > 4.5; rare gravel concretions wthrd. to FeO2.
X-3								13		12' occ. bedding @ 20°.
								14		
	Run 4	5.0'/5.0'	C-1					15		
								16		
								17		17.5'-18.0' SANDSTONE (SC)
X-4								18		18.5'-26.5' absence of FeO2.
	Run 5							19	CSMW	
								20		

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(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

(4011-930-0134-930)(Form GT.1A)(03/01/92)

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B10
Location - North: ________ East: ________
Date: ________
Geologist: ________
Drilling Equip.: ________

Surface Elevation: ________
Area: ________
Total Depth: ________
Company: ________ Project No.: 57378
Sample Type: ________

RMRS LOGGING SUPERVISOR APPROVAL ________ DATE ________

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL LITHOLOGIC LOG	SAMPLE DESCRIPTION
X-4	Run 5	5.0'/5.0'	C-1				CSMW	21		20' increased sand content in CS bedding e10°-20°; mod. FeO2 stained.
								22		
X-5								23		
								24		24' Fn-rounded gravel 3/4".
	Run 6	5.0'/5.0'	C-1					25		
								26		26.5'-34' CLAYSTONE; blk; unweathered soft; weak; no apparent bedding; crushed; no FeO2. PP>5; becomes thinly laminated w/depth
X-6							CSUW	27		
								28		
								29		
	Run 7	5.0'/5.0'	C-1					30		26'-27.5' sheared @~50°, slicks on shear sfc.
								31		29'-34' thinly laminated.
X-7								32		
								33		
								34		Backfilled w/ bentonite chips.
								35		
								36		
								37		
								38		
								39		
								40		

NOTES: General: USCS is modified for this log as follows:
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(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

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U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 1

Borehole Number: B-11
Location - North: East:
Date: 7/14/04
Geologist: Rick Heidrick
Drilling Equip.: CME-75

Surface Elevation:
Area: Near Women Creek
Total Depth: 14'
Company:
Project No.: 57378
Sample Type:

RMRS LOGGING SUPERVISOR APPROVAL

DATE Dry to 14' on 7/14/04

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/LITHOLOGIC LOG
X-1	Run 1	4.0/4.0'	C-1				Qc	0–3	
							Qbl?	3–4	o o o o
	DR	1.1/1.5		14, 40, 43				4.5–6	
X-2	Run 2	1.5/1.5'	C-1					6–7	
	DR	NR	NR	28, 23, 32			CSSW	7–8.5	
X-2	Run 3	2/2	C-1					9	
	DR	1.5/1.5'	L-1, L-2, L-3	9, 23, 37			CSMW	9.5–10.5	
X-3	Run 4	5/5	C-1				CSUW	11–14	

don't retain samples GW

SAMPLE DESCRIPTION

COLLUVIUM

0'-3' SC GRAVELLY SANDY CLAY. med. brn.; 50% med. plstc. clay; 25% fn to med. sand; 25% fn to cse gravel to 3"; damp; hard.

3'-7.5' GW SANDY GRAVEL: wt. to lt. gray; 80% fn. to cse gravel, rounded; cobbles to 6"; dry.

BEDROCK

7.5'-9' CLAYSTONE: med. gray mottled wt. sev. wthrd to residual soil; med. plsty.; damp; caliche nodules

9'-12.5' CLAYSTONE: med. gray mottled orange; mod. wthrd. Some FeO2 staining along bedding + frac sfcs; soft friable to weak; dry.

12.5'-14' CLAYSTONE; dk. grey to blk.; unwthrd.; mod. hd.; wk to mod. strong; dry.

Backfilled w/ bentonite chips.

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Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

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U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

PAGE 2 OF ___

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: B
Location - North: ______ East: ______
Date: ______
Geologist: ______
Drilling Equip.: ______

Surface Elevation: ______
Area: ______
Total Depth: ______ Project No.: 57378
Company: ______
Sample Type: ______

RMRS LOGGING SUPERVISOR APPROVAL ______ DATE ______

TOP/BOTTOM OF CORE IN BOX	TOP/BOTTOM OF INTERVAL	FEET OF CORE IN INTERVAL (FIELD MEASUREMENT)	SAMPLE NUMBER	FRACTURE ANGLE	BEDDING ANGLE	GRAIN SIZE DISTRIBUTION	USCS SYMBOL	DEPTH IN FEET	SOIL/ LITHOLOGIC LOG	SAMPLE DESCRIPTION
								21		
								22		
								23		
								24		
								25		
								26		
								27		
								28		
								29		
								30		
								31		
								32		
								33		
								34		
								35		
								36		
								37		
								38		
								39		
								40		

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

APPENDIX B

GEOTECHNICAL LABORATORY TEST DATA

APPENDIX B

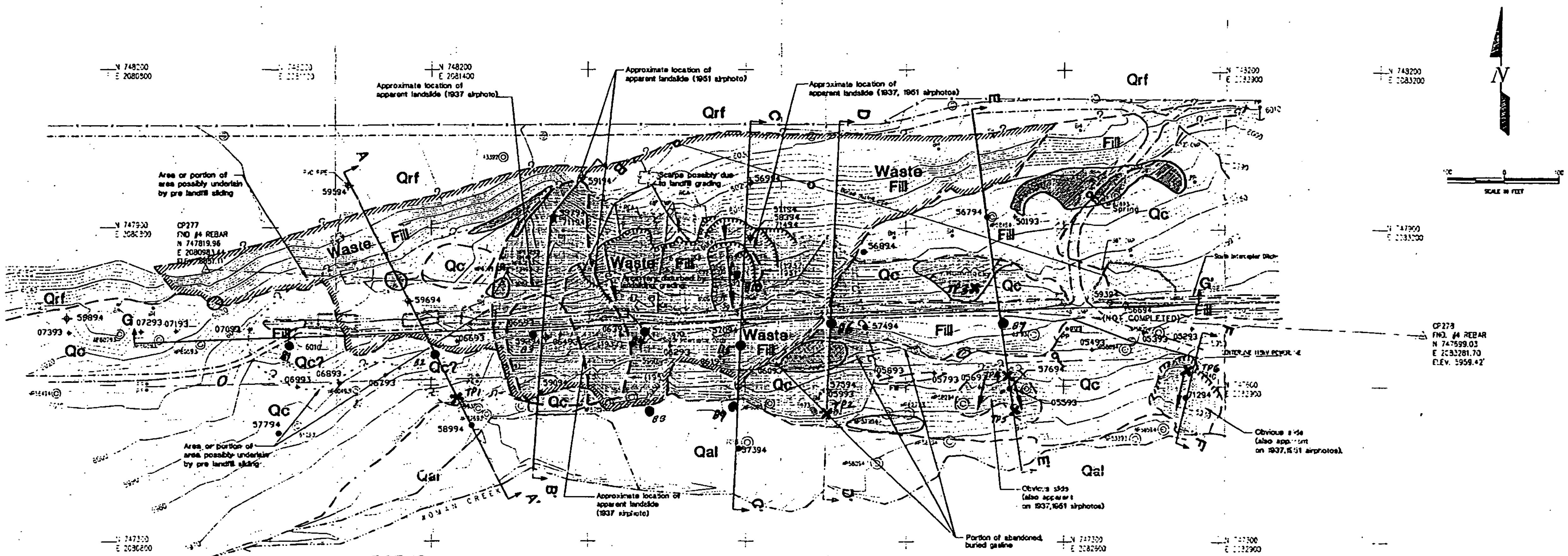
GEOTECHNICAL LABORATORY TEST DATA

Geotechnical laboratory testing for Phase 2b work was performed by Advanced Terra Testing, Inc. All test data is provided in a separate volume to this memorandum.

Submitted to the Colorado Department of Public Health and Environment and the U.S. Environmental Protection Agency on September 9, 2004.

APPENDIX C

GEOLOGIC MAP AND CROSS SECTIONS



LEGEND

Shallow groundwater area (indicated by thick, tall grass or other distinct vegetation).

Spring

Geologic contact, approximately located; dotted where concealed; queried where uncertain.

(1937) Approximate outline of apparent landslide from pre-landfill airphoto, with year of photo in parentheses.

Landslide area (some slide areas concealed by fill); based on examination of historic airphotos, field mapping and/or subsurface exploration; limits are approximately located, dotted where concealed, queried where uncertain. Arrow indicates discrete landslide with surface expression. See Note 1.

Scarp (landslide-related unless noted otherwise).

Waste Fill Sandy, Clayey Gravel and Cobbles (GC) derived from Qrf and Qc, and mixed with reflects historical production waste (wood, scrap metal, drums, graphite, concrete, etc.). Usually loose to medium dense; locally very loose. Inside edge of limits shown by

Fill Road fill, other construction-related fill (e.g. for buried outfall pipe). Presumably clean (i.e., without admixed waste).

Qc Colluvium : Sandy, Clayey Gravel and Cobbles (GC), and Sandy Clay (CL); finer Qc concentrated on lower slopes below South Interceptor Ditch. Generally medium dense (gravel), stiff to very stiff (clay). Locally less dense / softer.

Qal Valley Fill Alluvium : Sandy, Silty-Clayey Gravel and Cobbles (GM, GC). Generally medium dense to dense.

Qrf Rocky Flats Alluvium : Sandy, Clayey Gravel and Cobbles (GC). Generally dense. Includes local interbeds of stiff to hard clays and sandy clays (CL), and medium dense to very dense, fine, clean to clayey sands (SP, SC).

59694 Geotechnical Boring Installed with Shallow Well (in Fill, Qc, or Qrf)

59094 Geotechicel Boring, Backfilled

57194 Geotechnical Boring Installed with Bedrock Well

59894 Deep Monitoring Well (For Hydrogeologic Characterization)

07193 Cone Penetrometer Sounding (For Previous Hydrogeologic Characterization Work)

G G' Geologic Section

Surveyed Features on Base Topography Map Associated with Geologic Characterization Program

PHASE 2 - PROPOSED ADDITIONAL FIELD INVESTIGATION

•-Geotechnical Borehole

X-Backhoe Test Pit

Note:-Up to 2 additional boreholes assumed, adjacent to selected locations shown for additional sampling needs. B8 and B9 subject to acceptability for drilling at these locations. B8, B9, B10 subject to truck mounted drill rig accessibility.

NOTES:

1. Slide areas shown represent al areas with evidence of sliding documented during this investigation. Other areas of sliding possible exist within the study area, below about El. 6020 and above Woman Creek; due to lack of surface expression, such areas could only be identifiable by further subsurface exploration.
2. See Figures 4 though 10 for geologic sections.
3. Operable unit 5 topography as of january 4, 1995.

From Harlan/Freddy Report 10/6/95

REV	DATE	DESCRIPTION	DR BY	APP BY

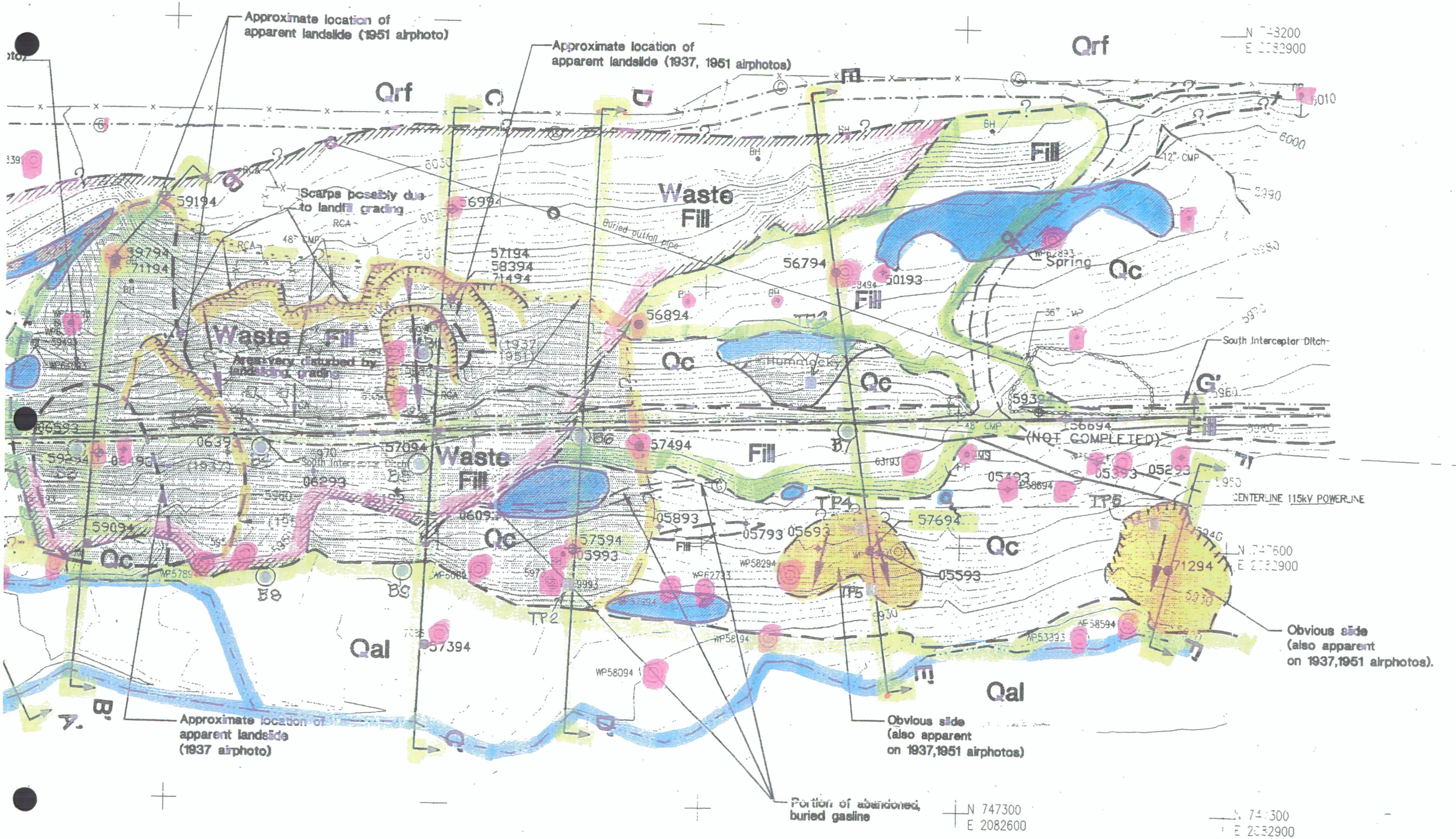
DES BY: F. HARLAN	PROJECT NO. 32242 — DATE MAY, 95
DRN BY: F. RIDENOUR	ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
CHK BY: F. HARLAN	OU-5 GEOTECHNICAL INVESTIGATION
ERV BY:	SHEET TITLE
CRV BY:	SITE GEOLOGIC MAP
APP BY: M. MOOERS	

57278. 6020
… 5/11/01

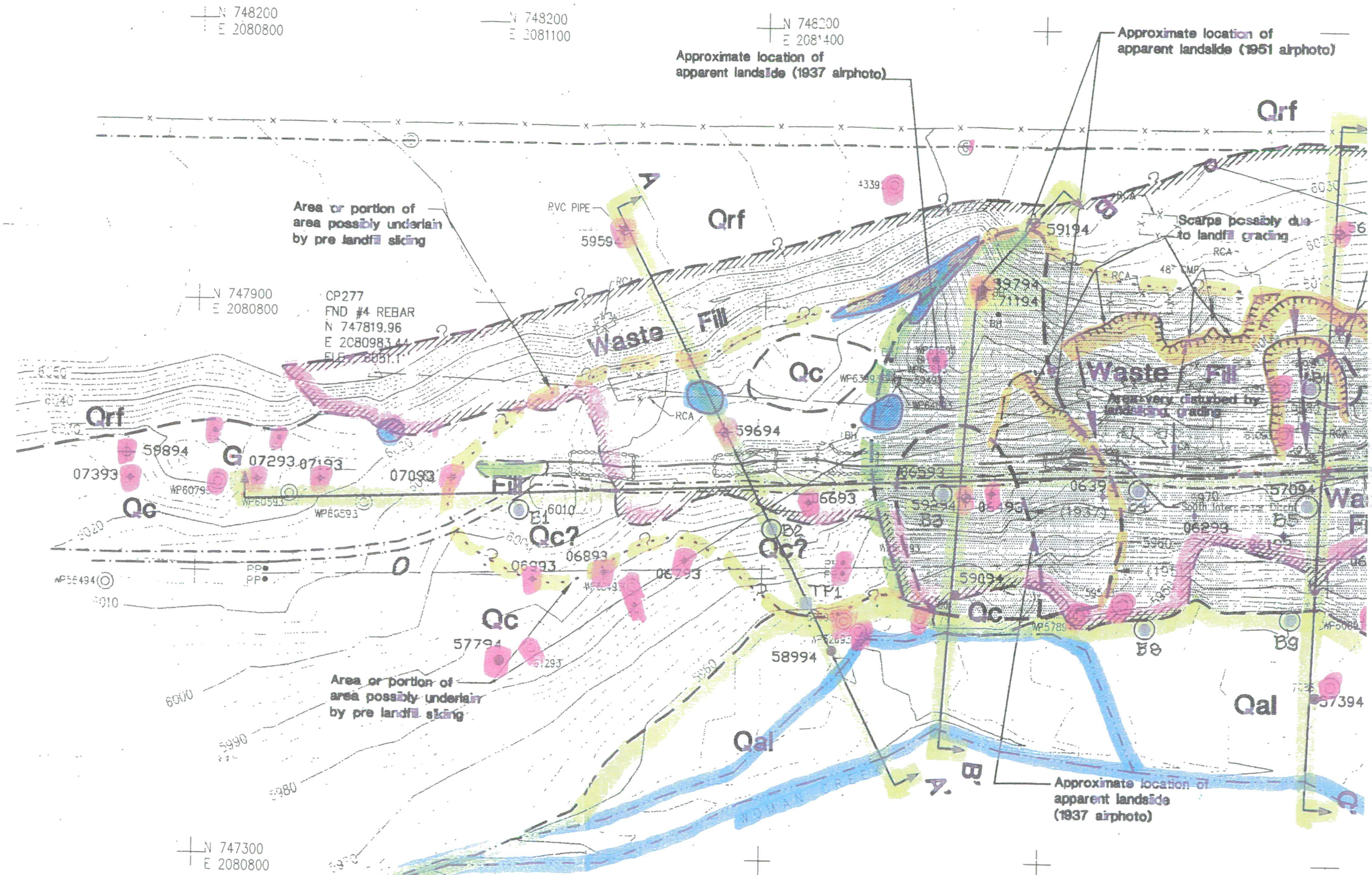
DRAFT

SHEET NO.

FIGURE 2

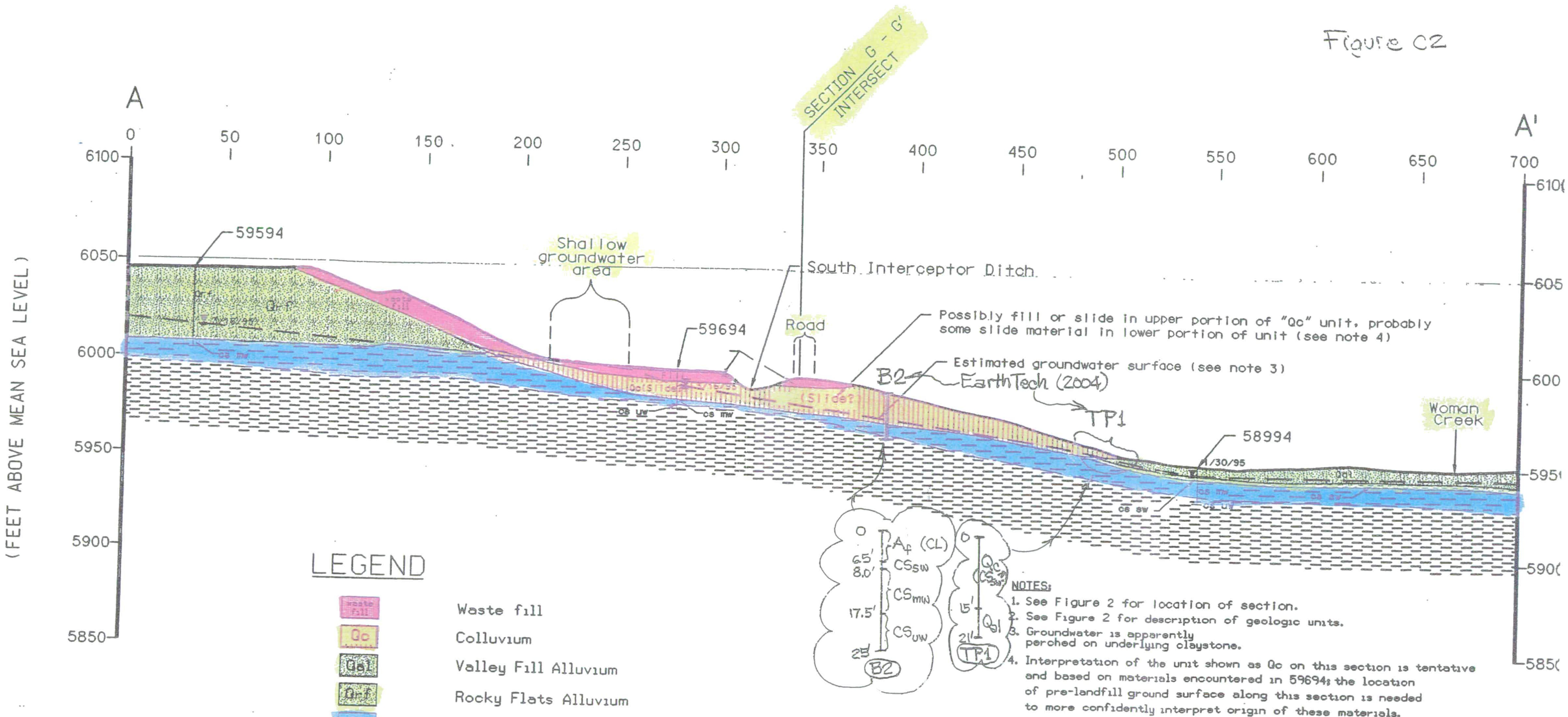


ndwater area (indicated by thick, tall grass or other distinct vegetation)


N 748200
E 2080800
N 748200
E 2081100
N 748200
E 2081400
Approximate location of apparent landslide (1937 airphoto)
Approximate location of apparent landslide (1951 airphoto)
Qrf
Area or portion of area possibly underlain by pre landfill sliding
PVC PIPE
Waste
Fill
Scarps possibly due to landfill grading
48" CMP
RCA
N 747900
E 2080800
CP277
FND #4 REBAR
N 747819.96
E 2080983.44
Qc
Waste Fill
Area very disturbed by landsliding, grading
59194
39794
71194
59894
07393
07293
07193
07093
59694
06693
06593
06393
57094
06293
Fill
Qc?
B1
B2
B3
B4
B5
B8
B9
06893
06993
06793
59094
TP1
58994
57794
Qal
Qc
A
A'
B
B'
57394
Approximate location of apparent landslide (1937 airphoto)
6000
5990
5980
N 747300
E 2080800

LEGEND

Figure C2



LEGEND

waste fill	Waste fill
Qc	Colluvium
Qal	Valley Fill Alluvium
Qrf	Rocky Flats Alluvium
CS	Laramie Formation Claystone:
sw	severely weathered
mw	moderately weathered
uw	unweathered

DRAFT

59694 Qc 3/16/95 cs mw — Geotechnical boring, backfilled or with monitoring well, showing geologic units, groundwater elevation and date measured.

NOTES:

1. See Figure 2 for location of section.
2. See Figure 2 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.
4. Interpretation of the unit shown as Qc on this section is tentative and based on materials encountered in 59694; the location of pre-landfill ground surface along this section is needed to more confidently interpret origin of these materials.

50 0 50
SCALE IN FEET

PROJECT #:	32242
ORIG. DATE:	MAY, 1995
PREP. BY:	R. RIDENOUR
REV. BY:	R. HARLAN
SCALE:	1" = 50'
FILE NAME:	N:*...*ROCKY*AA.DGN

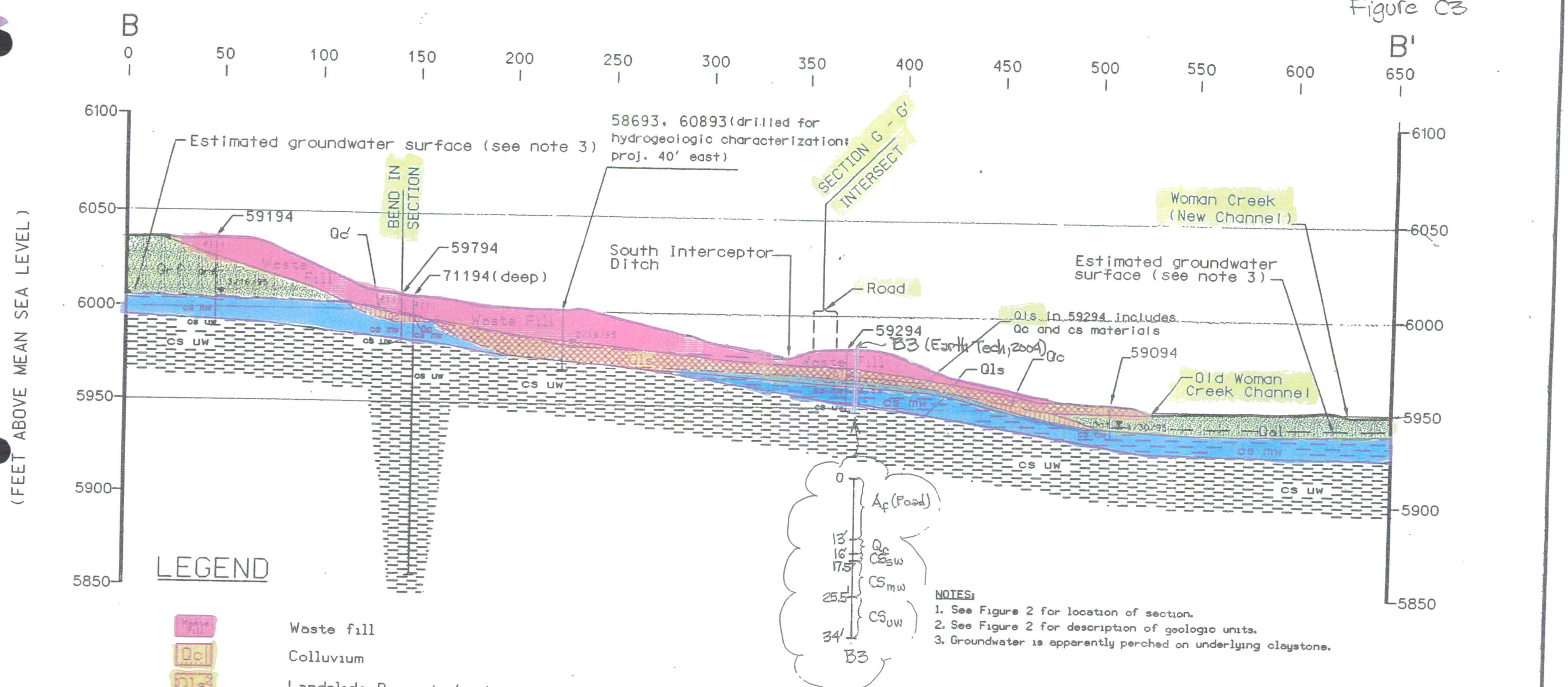
Prepared for:
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN COLO

PREPDATE: SEPTEMBER 1995

FIGURE 4
OU-5 GEOTECHNICAL INVESTIG
SECTION A-A'

2app\ustation\out\dgn\aa.dg Sep. 27, 1995 15:22:56

Figure C3



LEGEND

Waste Fill	Waste fill
Qc	Colluvium
Qls	Landslide Deposits (unit may contain material from several discrete landslides).
Qal	Valley Fill Alluvium
Qrf	Rocky Flats Alluvium
cs	Laramie Formation Claystone:
sw	severely weathered
mw	moderately weathered
uw	unweathered

59194 Qrf 3/16/95 cs mw — Geotechnical boring, backfilled or with monitoring well, showing geologic units, groundwater elevation and date measured.

NOTES:
1. See Figure 2 for location of section.
2. See Figure 2 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.

50 0 50
SCALE IN FEET

DRAFT

Prepared for:
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN COLORADO

PREPDATE: SEPTEMBER 1995

PROJECT #:	32242
ORIG. DATE:	MAY, 1995
PREP. BY:	R. RIDENOUR
REV. BY:	R. HARLAN
SCALE:	1" = 50'

FIGURE 5
OU-5 GEOTECHNICAL INVESTIGATION
SECTION B-B'

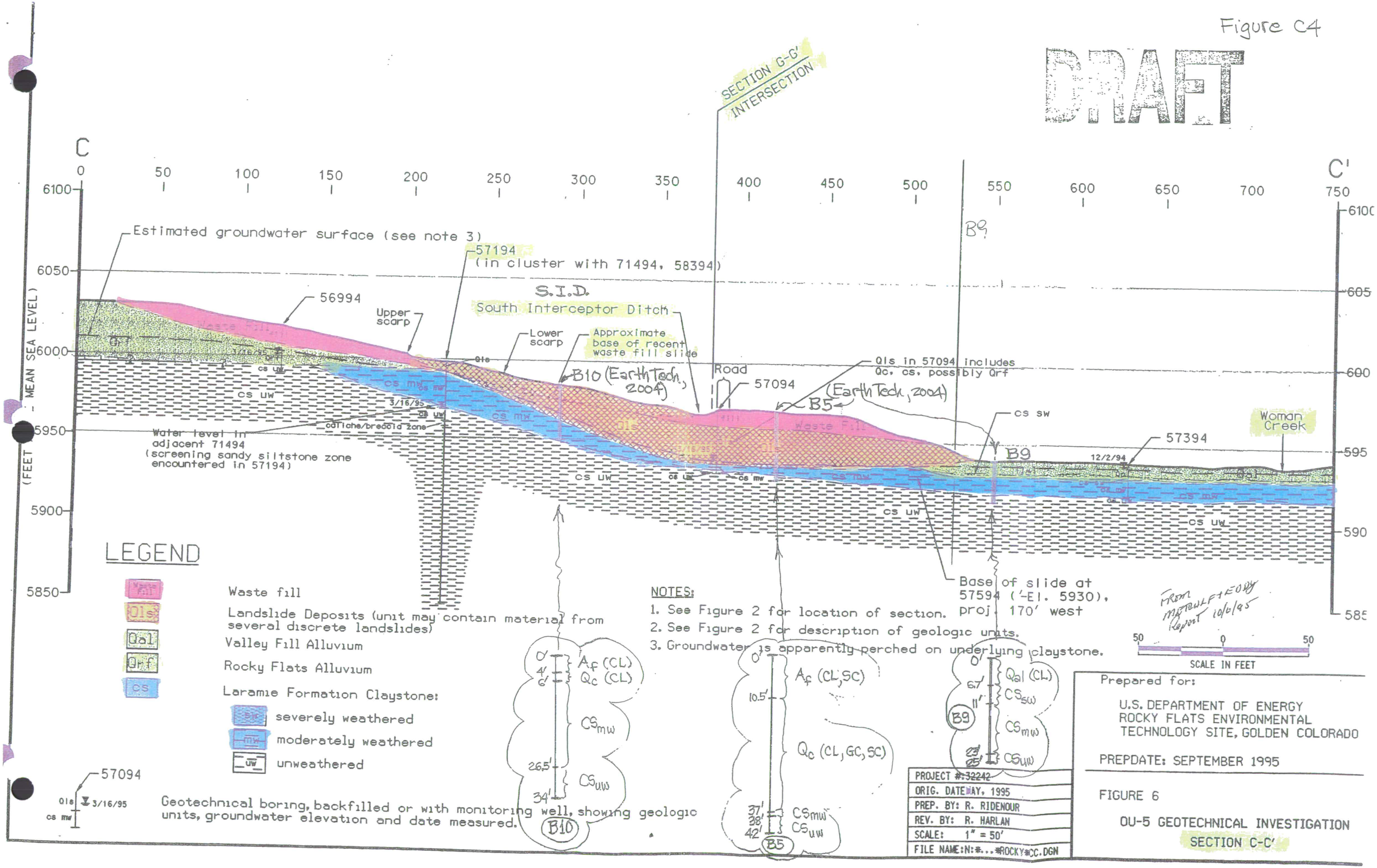


Figure C4
DRAFT
SECTION G-G' INTERSECTION
C
C'
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
6100
6050
6000
5950
5900
5850
(FEET - MEAN SEA LEVEL)
Estimated groundwater surface (see note 3)
57194 (in cluster with 71494, 58394)
56994
Upper scarp
S.I.D.
South Interceptor Ditch
Lower scarp
Approximate base of recent waste fill slide
Road
57094
B10 (Earth Tech, 2004)
B5 (Earth Tech, 2004)
Qls in 57094 includes Qc, cs, possibly Qrf
B9
cs sw
57394
Woman Creek
Waste Fill
Qrf
Qls
Qal
cs uw
cs mw
3/16/95
12/2/94
caliche/brecciated zone
Water level in adjacent 71494 (screening sandy siltstone zone encountered in 57194)
Base of slide at 57594 (~El. 5930), proj. 170' west
LEGEND
Waste fill
Landslide Deposits (unit may contain material from several discrete landslides)
Valley Fill Alluvium
Rocky Flats Alluvium
Laramie Formation Claystone:
severely weathered
moderately weathered
unweathered
57094
Qls 3/16/95
cs mw
Geotechnical boring, backfilled or with monitoring well, showing geologic units, groundwater elevation and date measured.
NOTES:
1. See Figure 2 for location of section.
2. See Figure 2 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.
0' 4' 6' Af (CL) Qc (CL) CSmw 26.5' CSuw 34' B10
0' Af (CL, SC) 10.5' Qc (CL, GC, SC) 37' 38' 42' CSmw CSuw B5
0' Qal (CL) 6.7' CSsw 11' CSmw 23' 25' CSuw B9
From Metcalf + Eddy Report 10/6/95
50 0 50
SCALE IN FEET
PROJECT #:32242
ORIG. DATE: MAY, 1995
PREP. BY: R. RIDENOUR
REV. BY: R. HARLAN
SCALE: 1" = 50'
FILE NAME: N:\...\ROCKY\CC.DGN
Prepared for:
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN COLORADO
PREPDATE: SEPTEMBER 1995
FIGURE 6
OU-5 GEOTECHNICAL INVESTIGATION
SECTION C-C'

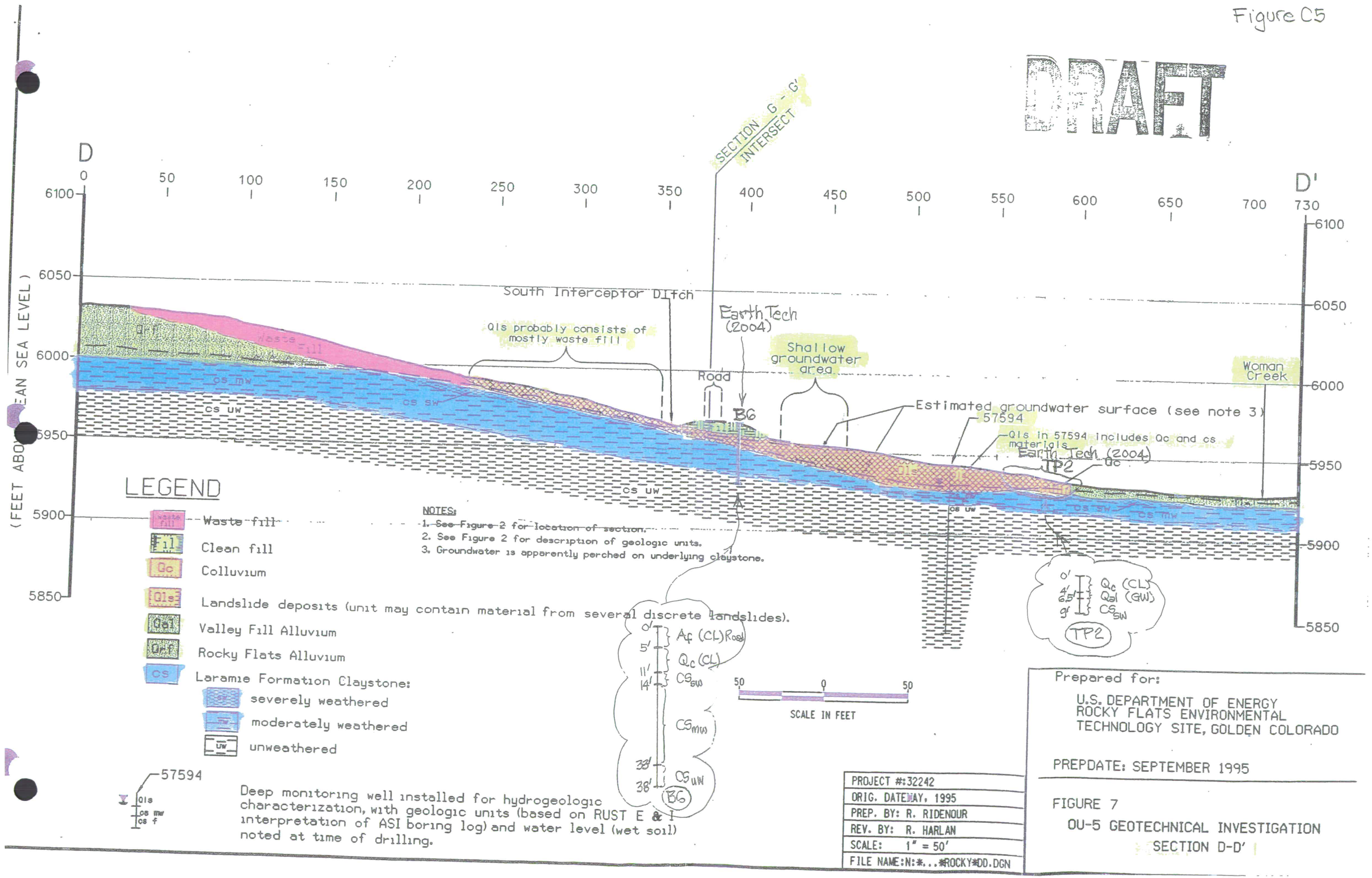


Figure C5
DRAFT
SECTION G - G' INTERSECT
D
D'
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
730
6100
6050
6000
5950
5900
5850
(FEET ABOVE MEAN SEA LEVEL)
South Interceptor Ditch
Earth Tech (2004)
Qls probably consists of mostly waste fill
Shallow groundwater area
Road
BG
Woman Creek
Estimated groundwater surface (see note 3)
57594
Qls in 57594 includes Qc and cs materials
Earth Tech (2004)
TP2
Qc
Qrf
Waste Fill
cs mw
cs sw
cs uw
Qls
LEGEND
Waste fill
Clean fill
Colluvium
Landslide deposits (unit may contain material from several discrete landslides).
Valley Fill Alluvium
Rocky Flats Alluvium
Laramie Formation Claystone:
severely weathered
moderately weathered
unweathered
NOTES:
1. See Figure 2 for location of section.
2. See Figure 2 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.
0' Af (CL) Road
5' Qc (CL)
11' 14' CS SW
CS MW
33' 38' CS UW
BG
0' 4' 6.5' 9' Qc (CL) Qal (GW) CS SW
TP2
57594
Qls cs mw cs f
Deep monitoring well installed for hydrogeologic characterization, with geologic units (based on RUST E & I interpretation of ASI boring log) and water level (wet soil) noted at time of drilling.
50 0 50
SCALE IN FEET
PROJECT #:32242
ORIG. DATE: MAY, 1995
PREP. BY: R. RIDENOUR
REV. BY: R. HARLAN
SCALE: 1" = 50'
FILE NAME:N:*...*ROCKY*DD.DGN
Prepared for:
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN COLORADO
PREPDATE: SEPTEMBER 1995
FIGURE 7
OU-5 GEOTECHNICAL INVESTIGATION
SECTION D-D'

Figure C6

DRAFT

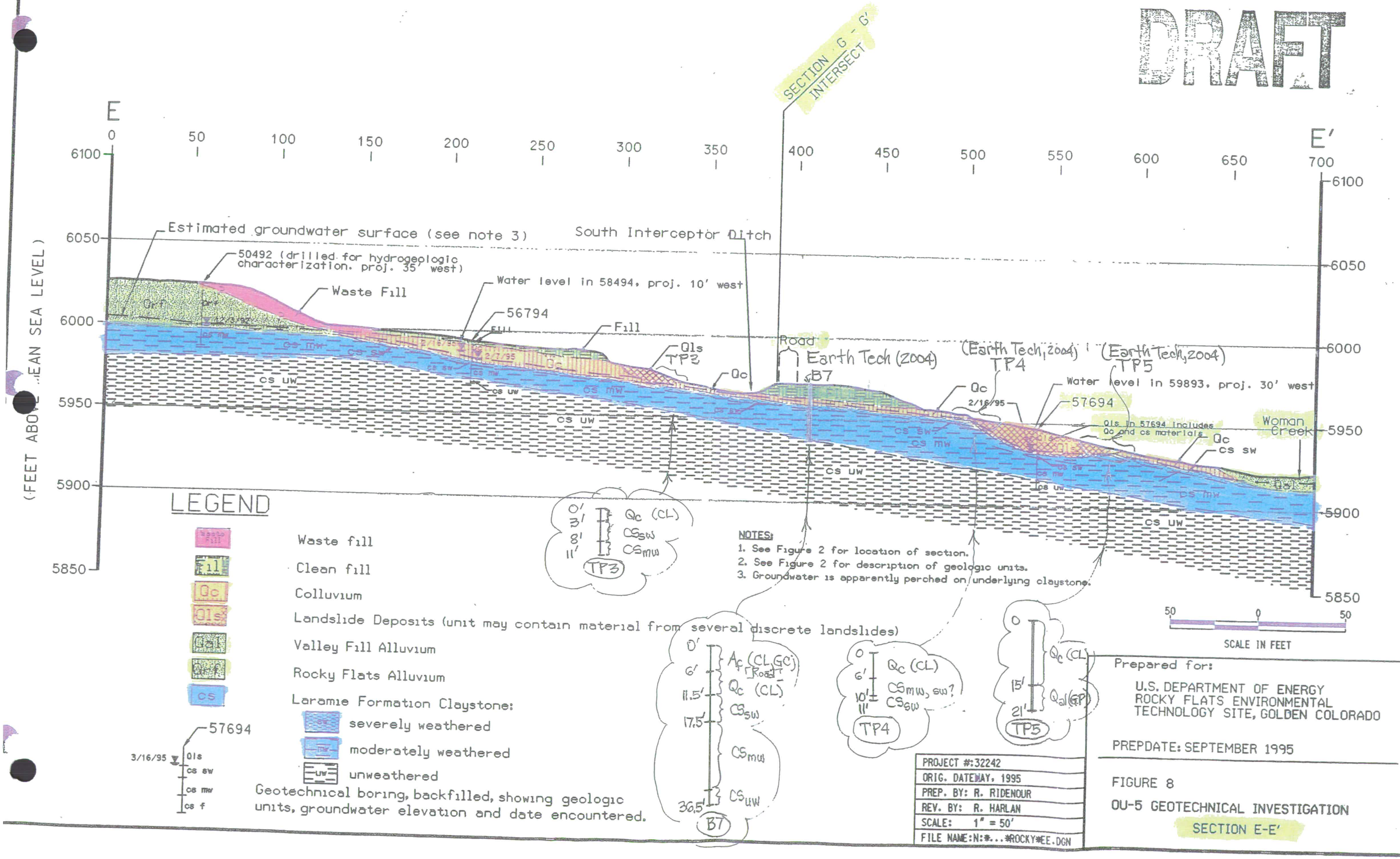
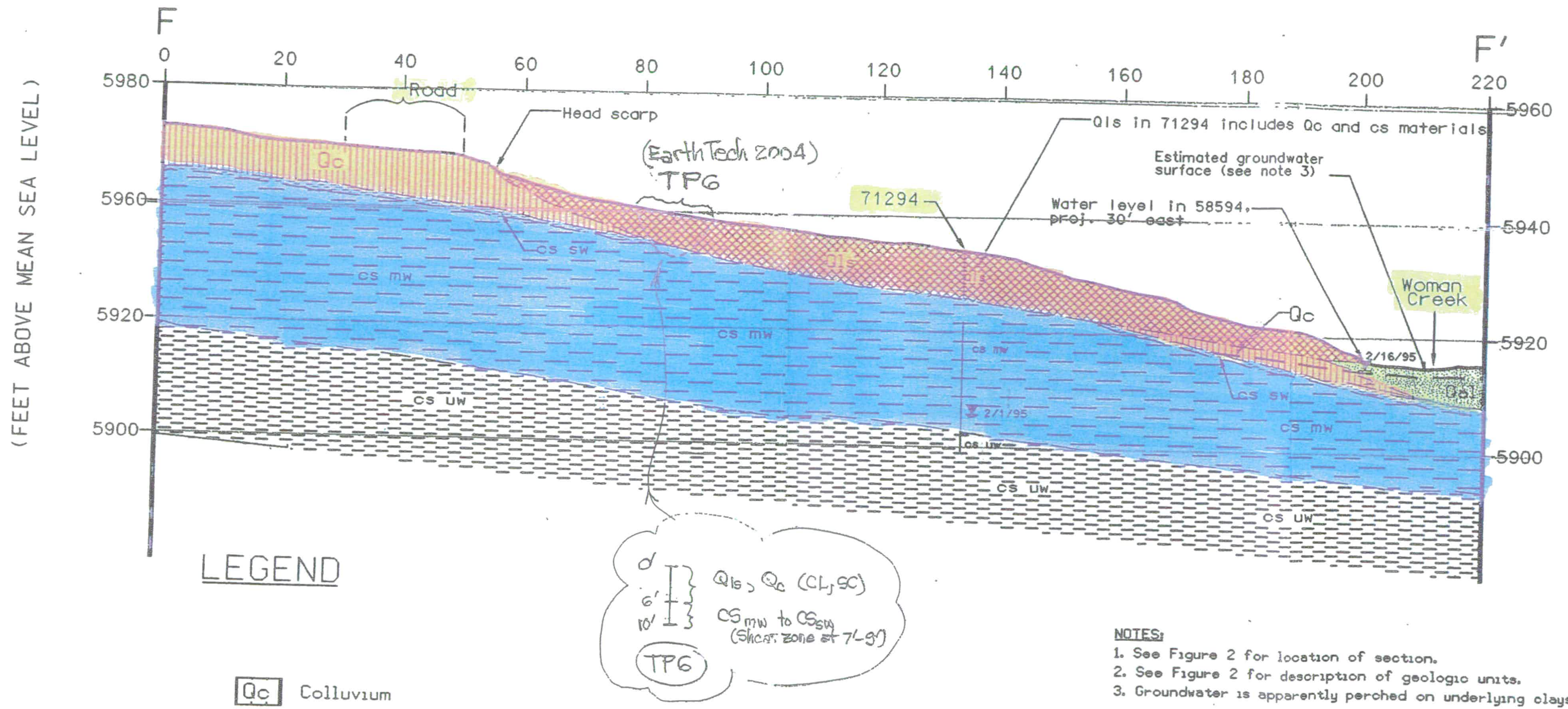


Figure C7

DRAFT



LEGEND

Qc Colluvium

Qls Landslide Deposits (unit may contain material from several discrete landslides)

Qal Valley Fill Alluvium

cs Laramie Formation Claystone:

- sw severely weathered
- mw moderately weathered
- uw unweathered

71294 (Qls, 2/1/95 cs mw, cs f) Geotechnical boring, backfilled, showing geologic units, groundwater elevation and date encountered.

NOTES:
1. See Figure 2 for location of section.
2. See Figure 2 for description of geologic units.
3. Groundwater is apparently perched on underlying claystone.

20 0 20
SCALE IN FEET

PROJECT #:	32242
ORIG. DATE:	MAY, 1995
PREP. BY:	R. RIDENOUR
REV. BY:	R. HARLAN
SCALE:	1" = 50'
FILE NAME:	N:\...\ROCKY\AA.DGN

Prepared for:

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN COLORADO

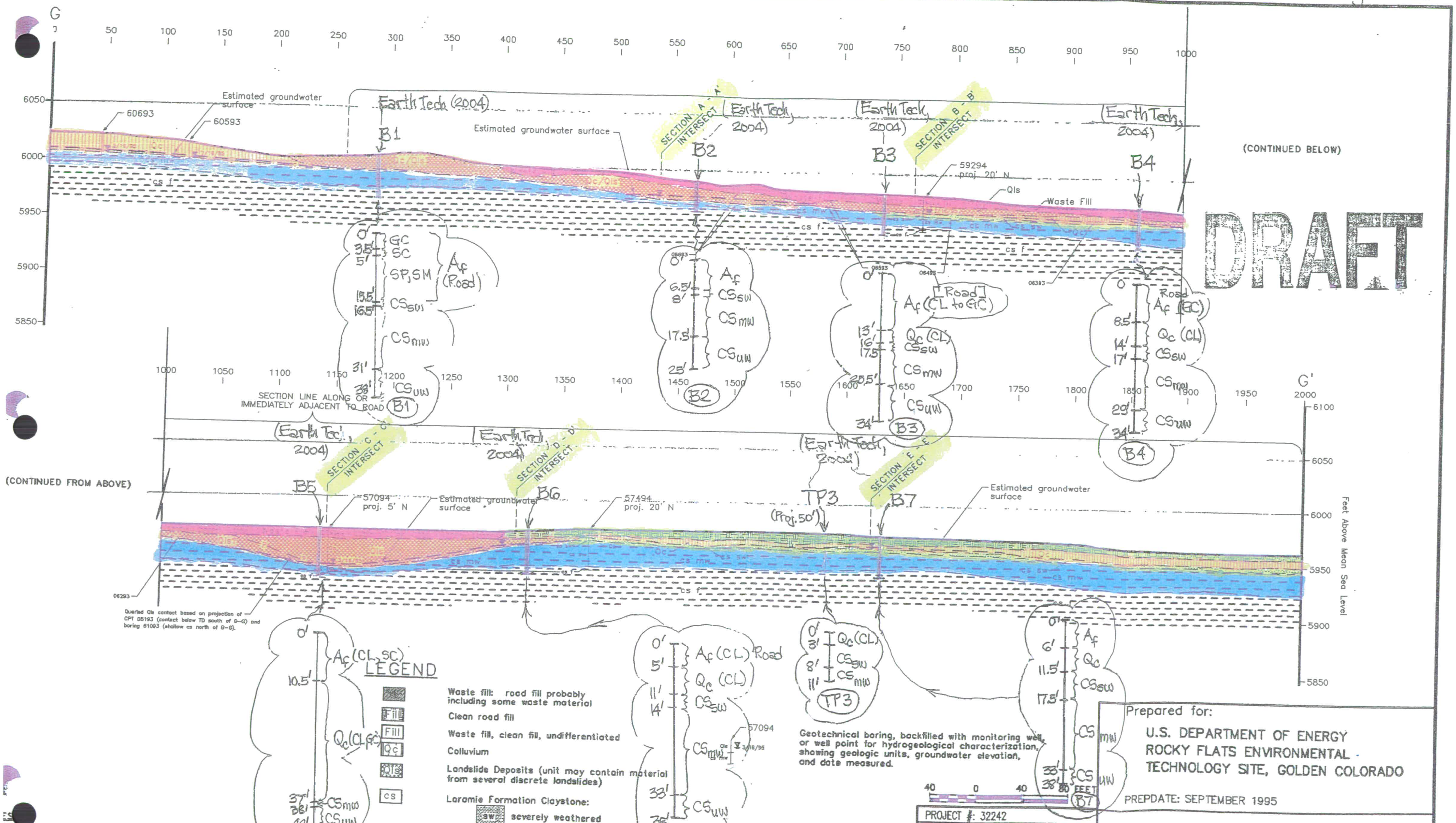
PREPDATE: SEPTEMBER 1995

FIGURE 9

OU-5 GEOTECHNICAL INVESTIGATION

SECTION F-F'

Figure C8



NOTES:
See Figure 2 for location of section.
See Figure 2 for description of geologic units.
Geologic contacts from projected exploration locations are adjusted to assumed elevation along line of section.

PROJECT #:	32242
ORIG. DATE:	MAY, 1995
PREP. BY:	R. RIDENOUR
REV. BY:	R. HARLAN
SCALE:	1" = 80'
FILE NAME:	j:\...\rckyflats\g1g1.dwg

Prepared for:
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN COLORADO

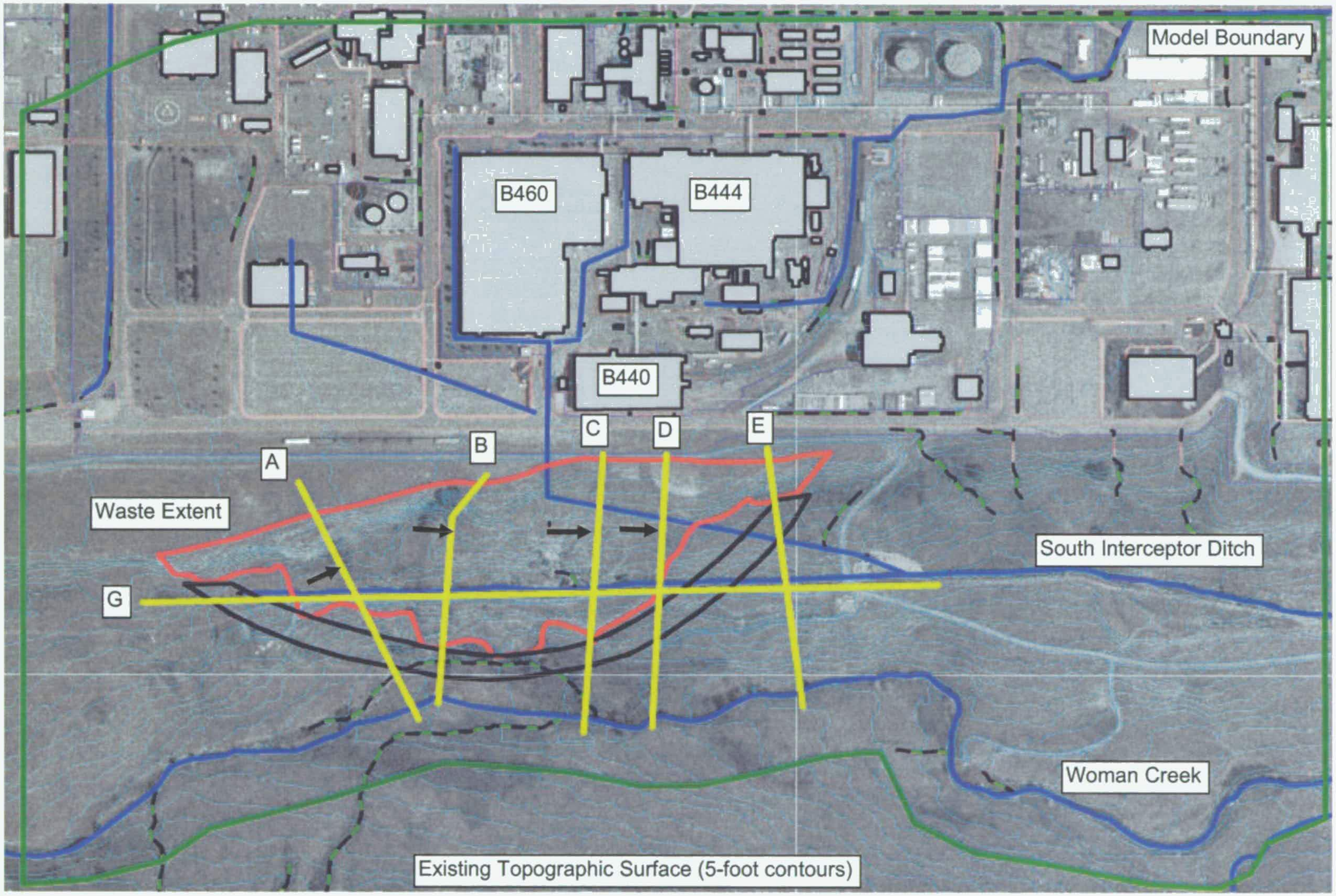
PREPDATE: SEPTEMBER 1995

FIGURE 10
OU-5 GEOTECHNICAL INVESTIGATION
SECTION G-G'

Appendix D

APPENDIX D

GROUNDWATER MODELING INPUT



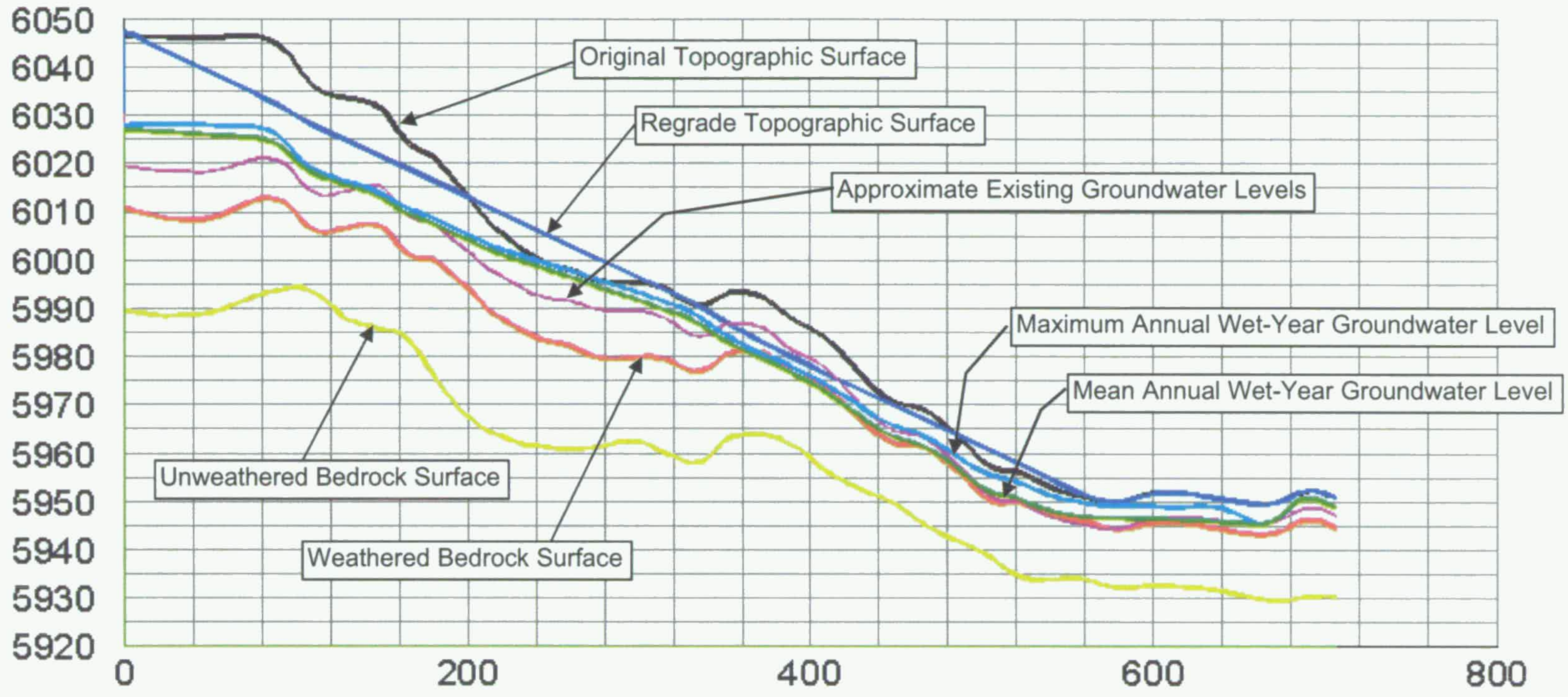
NOTE:

A Vertical Profile Location - Initially defined in Metcalf & Eddy Report (9/1995)

Profile View Direction

Integrated Hydro Systems, LLC

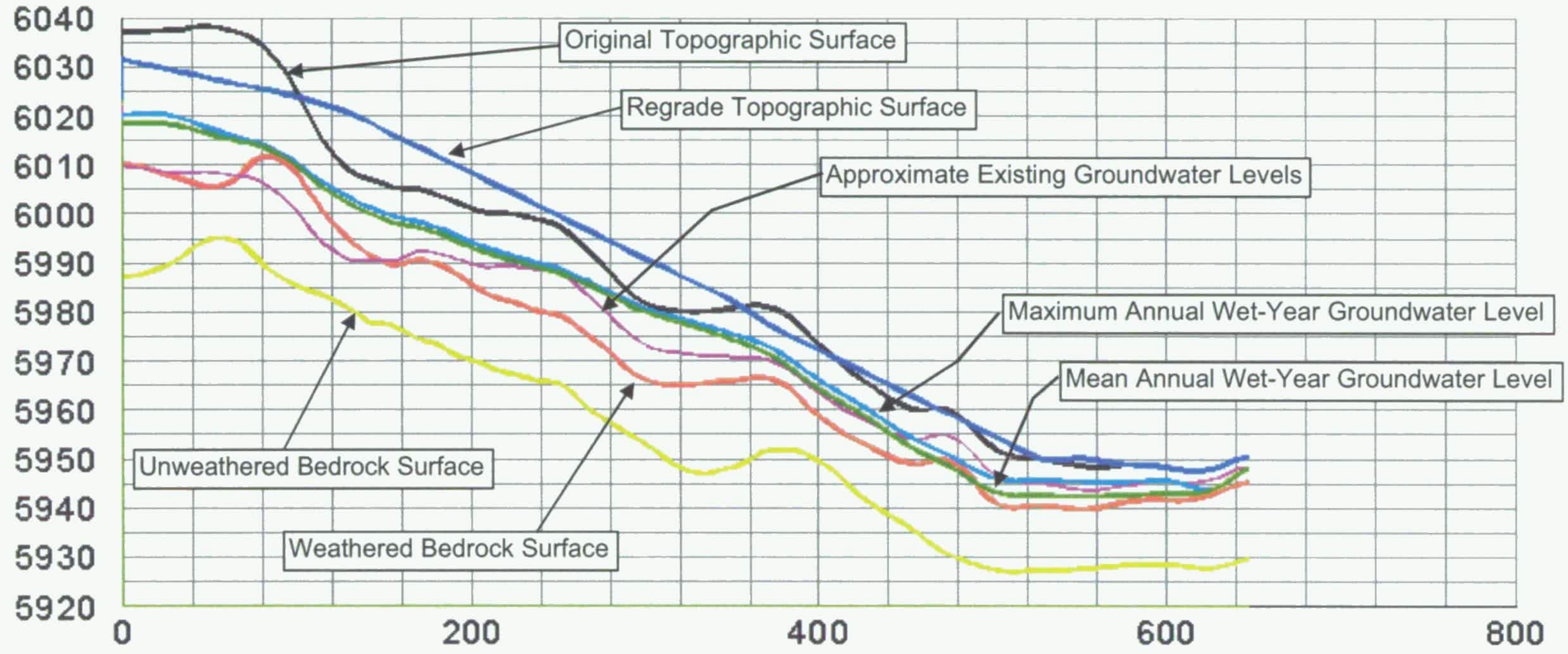
OLF study area, waste extent, current surface topography, and vertical profile locations.



NOTES:
1) Horizontal and Vertical Units are feet
2) Vertical exaggeration is 3x
3) Wet Year water levels based on 100-year climate sequence (see OLF groundwater tech report for details).

Vertical Profile A
Geologic Surfaces and Groundwater Levels

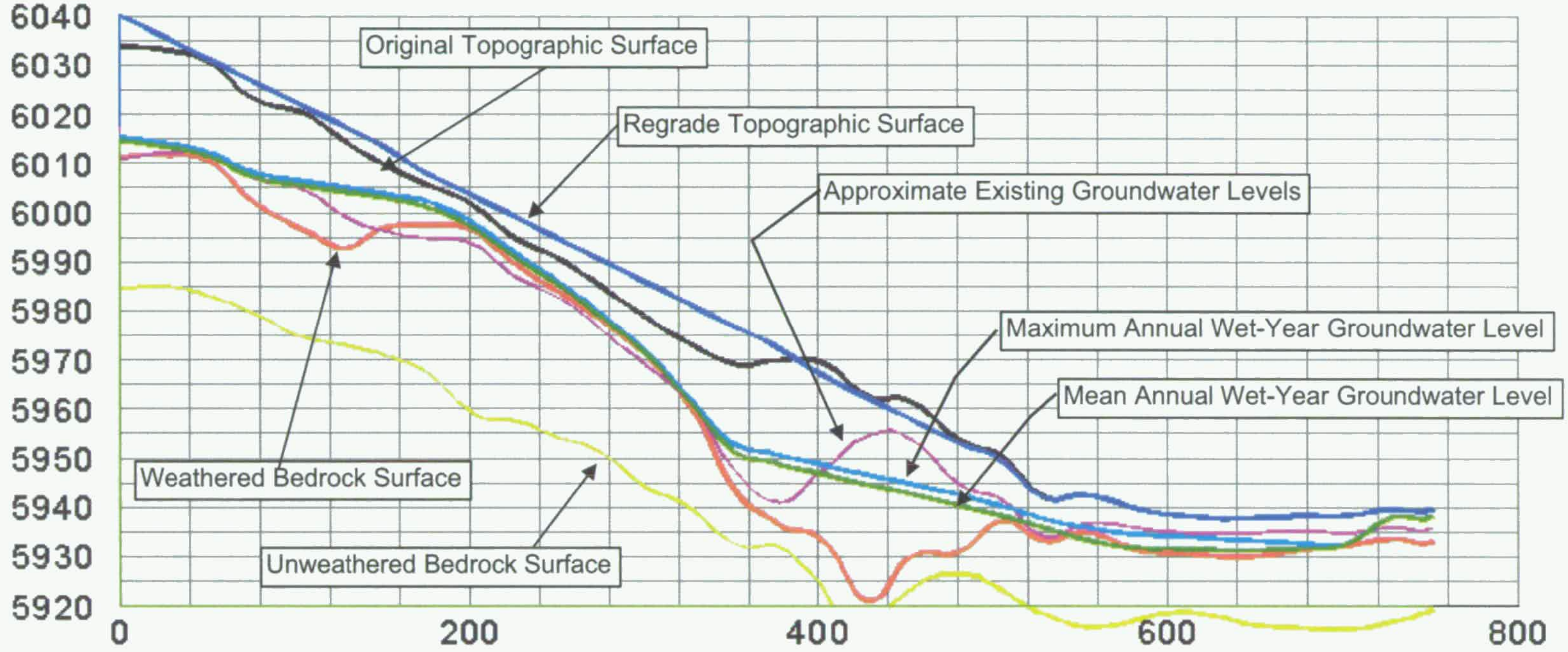
Integrated Hydro Systems, LLC



NOTES:
1) Horizontal and Vertical Units are feet
2) Vertical exaggeration is 3x
3) Wet Year water levels based on 100-year climate sequence (see OLF groundwater tech report for details).

Integrated Hydro Systems, LLC

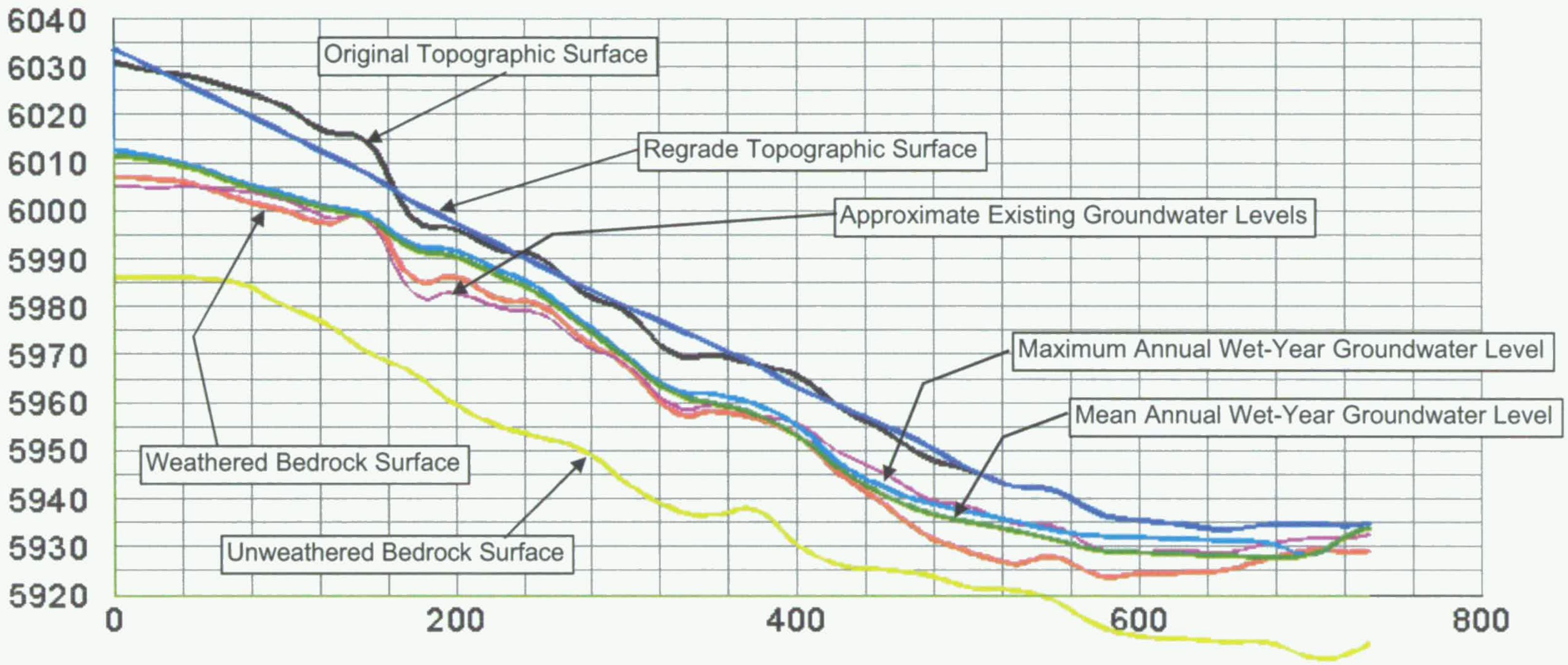
Vertical Profile B
Geologic Surfaces and Groundwater Levels



NOTES:
1) Horizontal and Vertical Units are feet
2) Vertical exaggeration is 3x
3) Wet Year water levels based on 100-year climate sequence (see OLF groundwater tech report for details).

Integrated Hydro Systems, LLC

Vertical Profile C
Geologic Surfaces and Groundwater Levels



NOTES:
1) Horizontal and Vertical Units are feet
2) Vertical exaggeration is 3x
3) Wet Year water levels based on 100-year climate sequence (see OLF groundwater tech report for details).

Integrated Hydro Systems, LLC

Vertical Profile D
Geologic Surfaces and Groundwater Levels

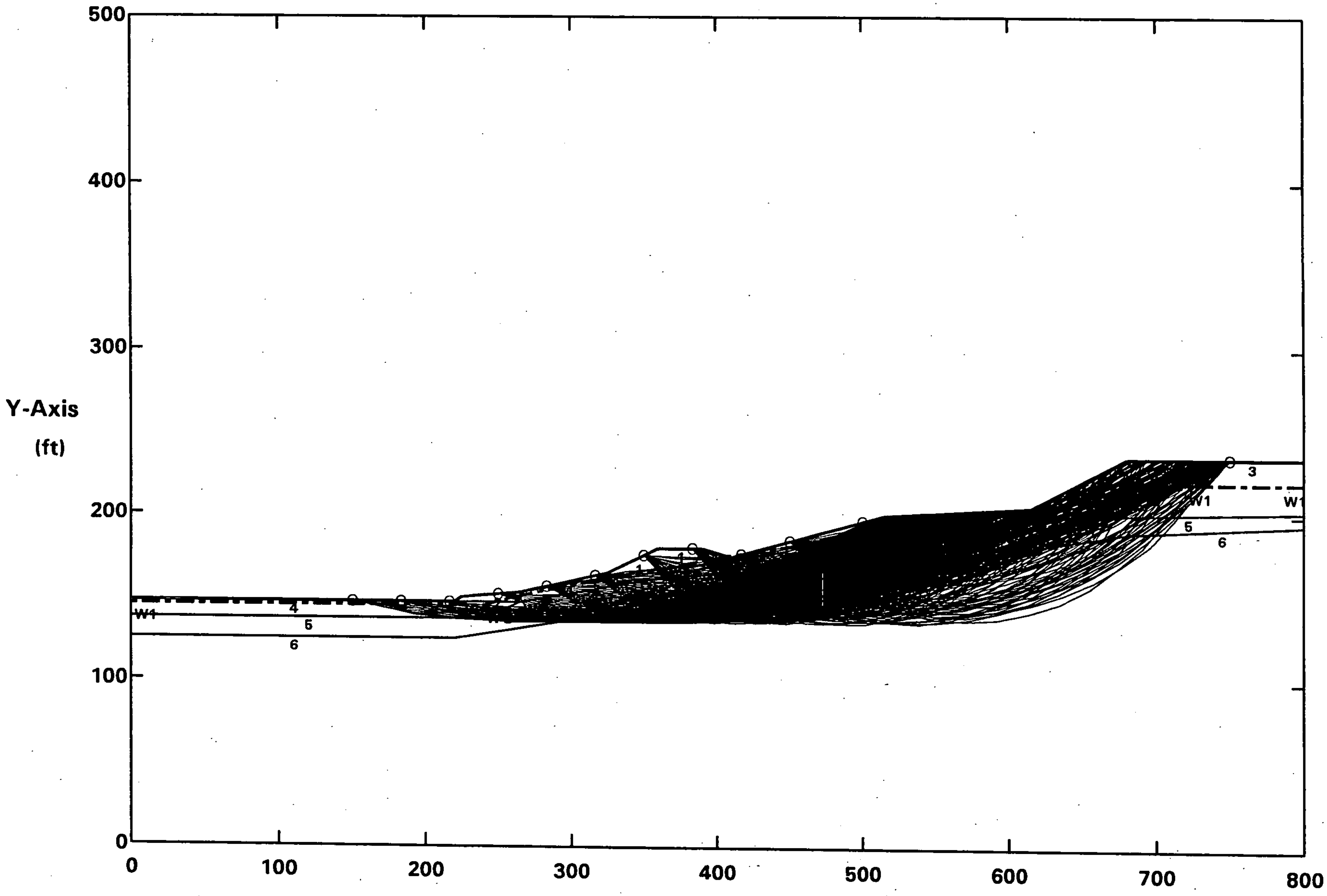
APPENDIX E

STABILITY ANALYSES

M&E SECTION B-B' – STATIC

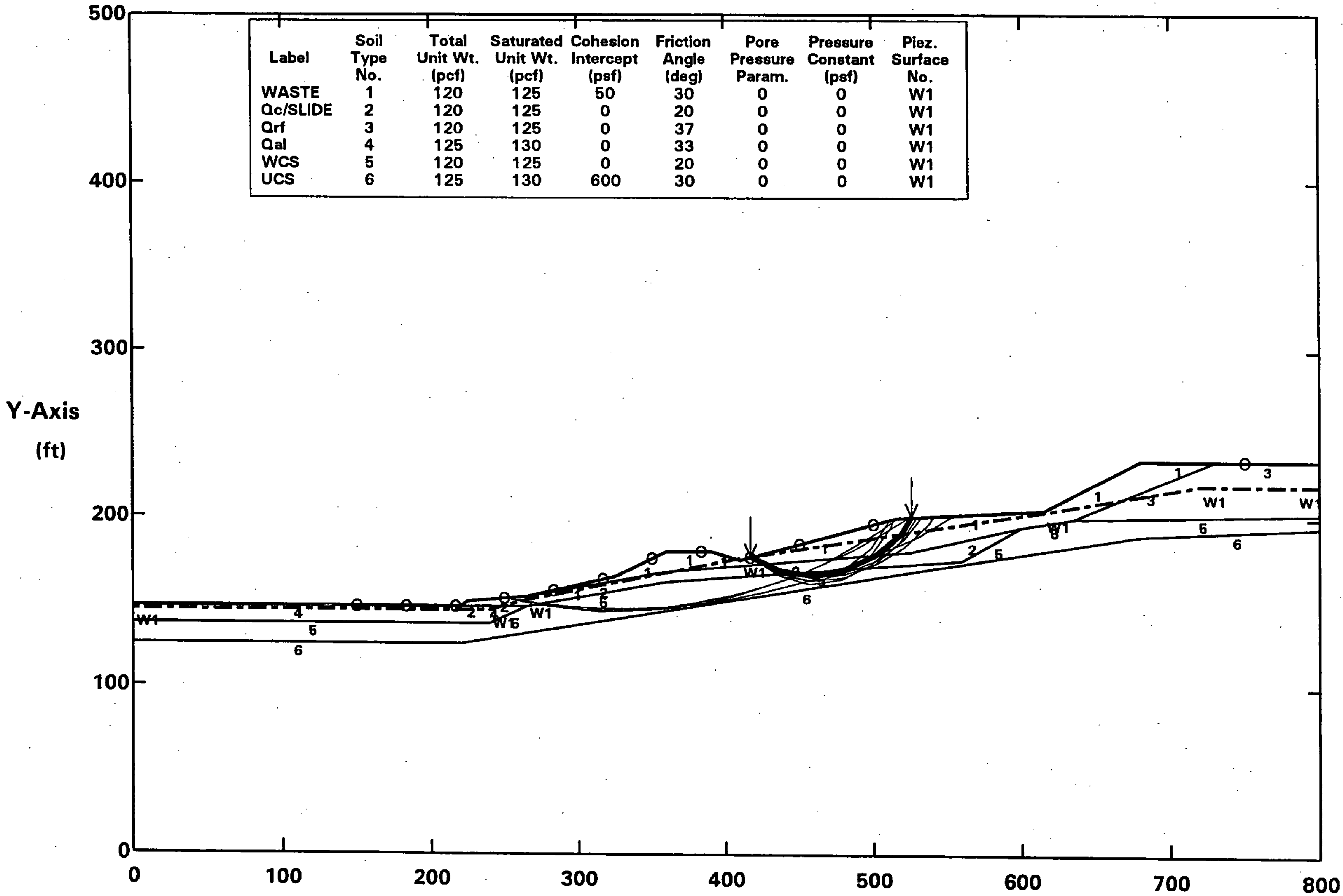
EXISTING CONDITIONS

ROCKY FLATS OLF - M&E SECTION B - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:BEACS.PLT By: STAN KLINE 10-22-04 2:12am



Factors Of Safety Calculated By The Modified Bishop Method

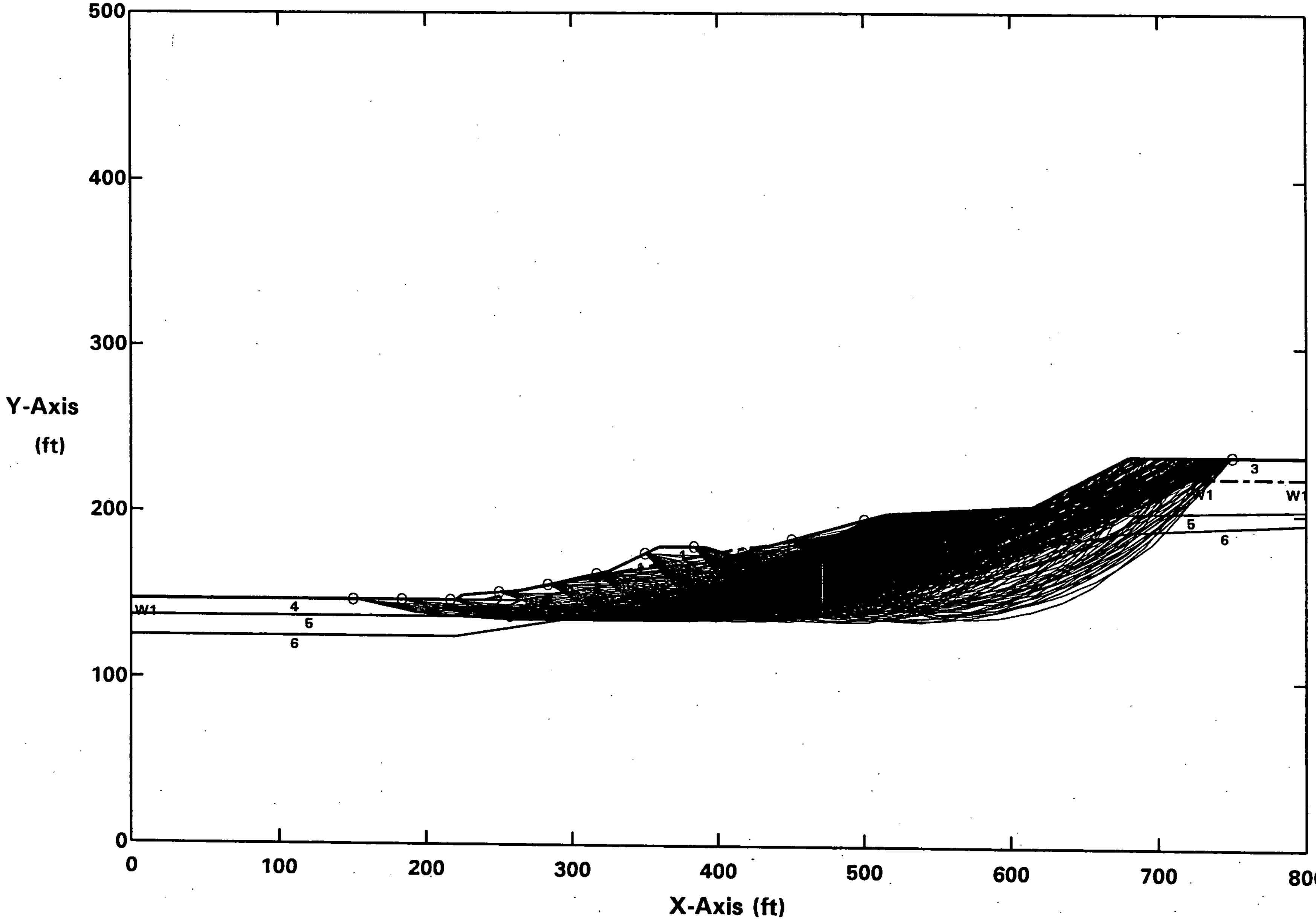
ROCKY FLATS OLF - M&E SECTION B - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:BEACS.PLT By: STAN KLINE 10-22-04 2:12am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 1.49 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

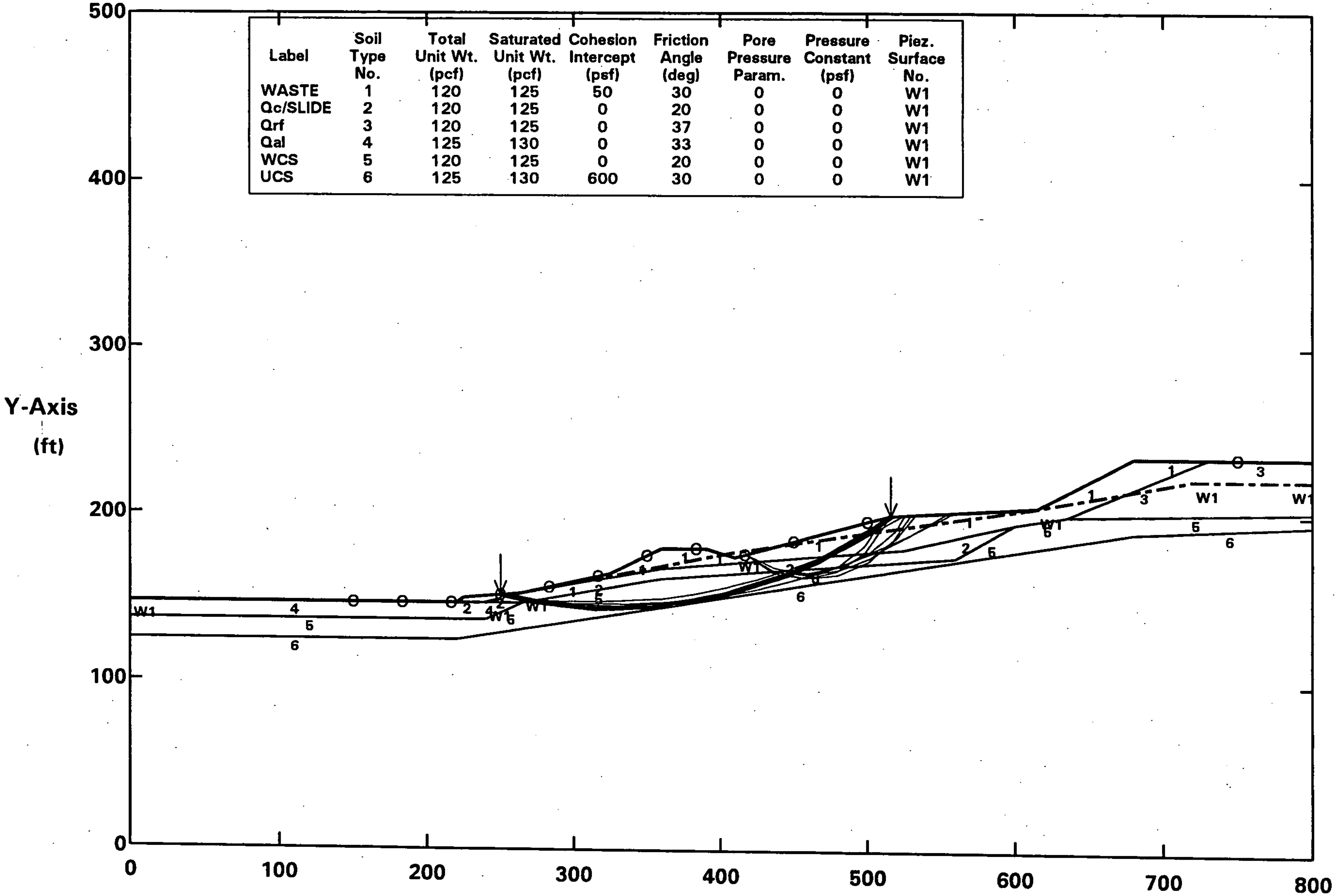
ROCKY FLATS OLF - M&E SECTION B - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:BEHCS.PLT By: STAN KLINE 10-23-04 6:56pm



Factors Of Safety Calculated By The Modified Bishop Method

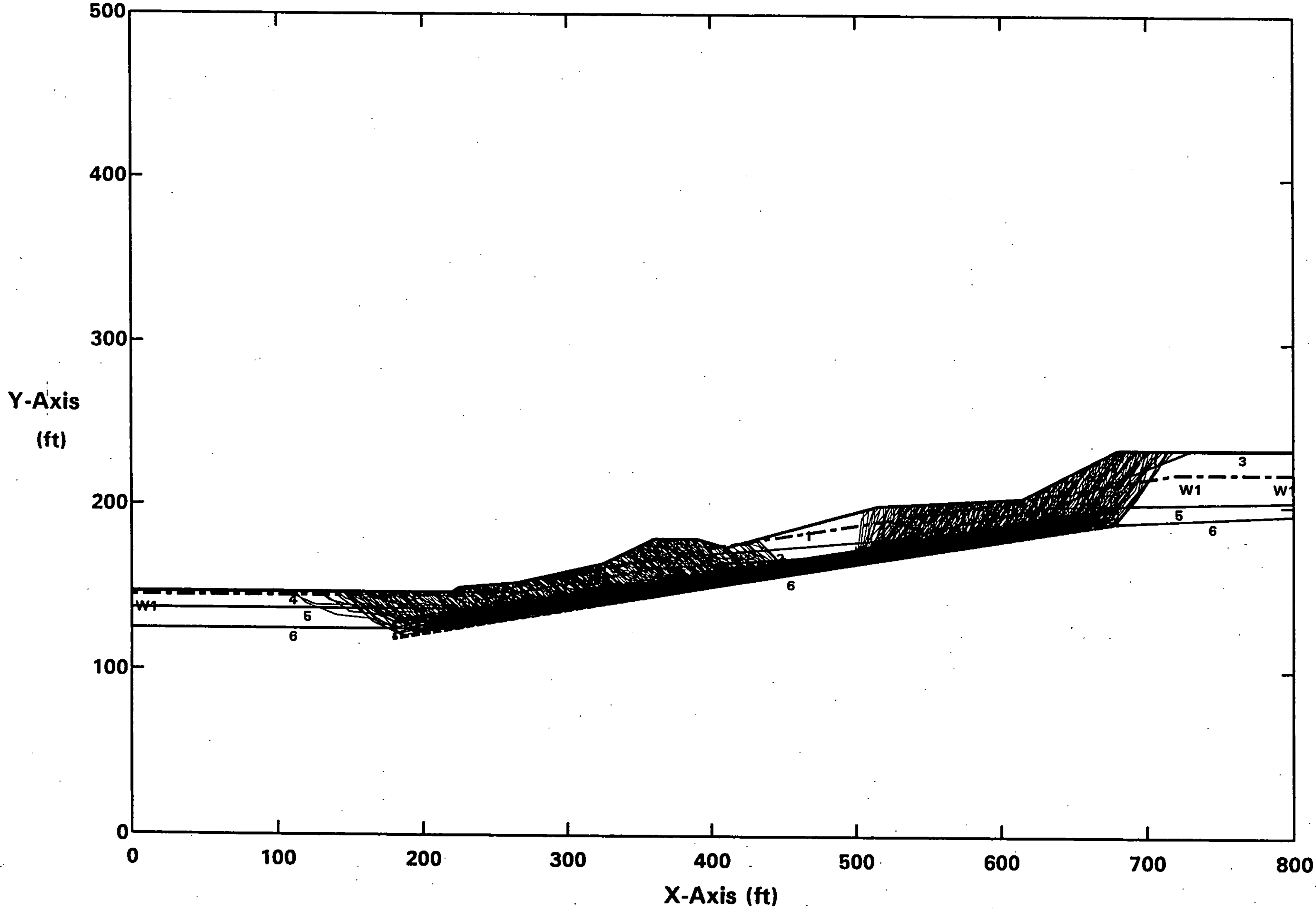
ROCKY FLATS OLF - M&E SECTION B - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:BEHCS.PLT By: STAN KLINE 10-23-04 6:56pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1



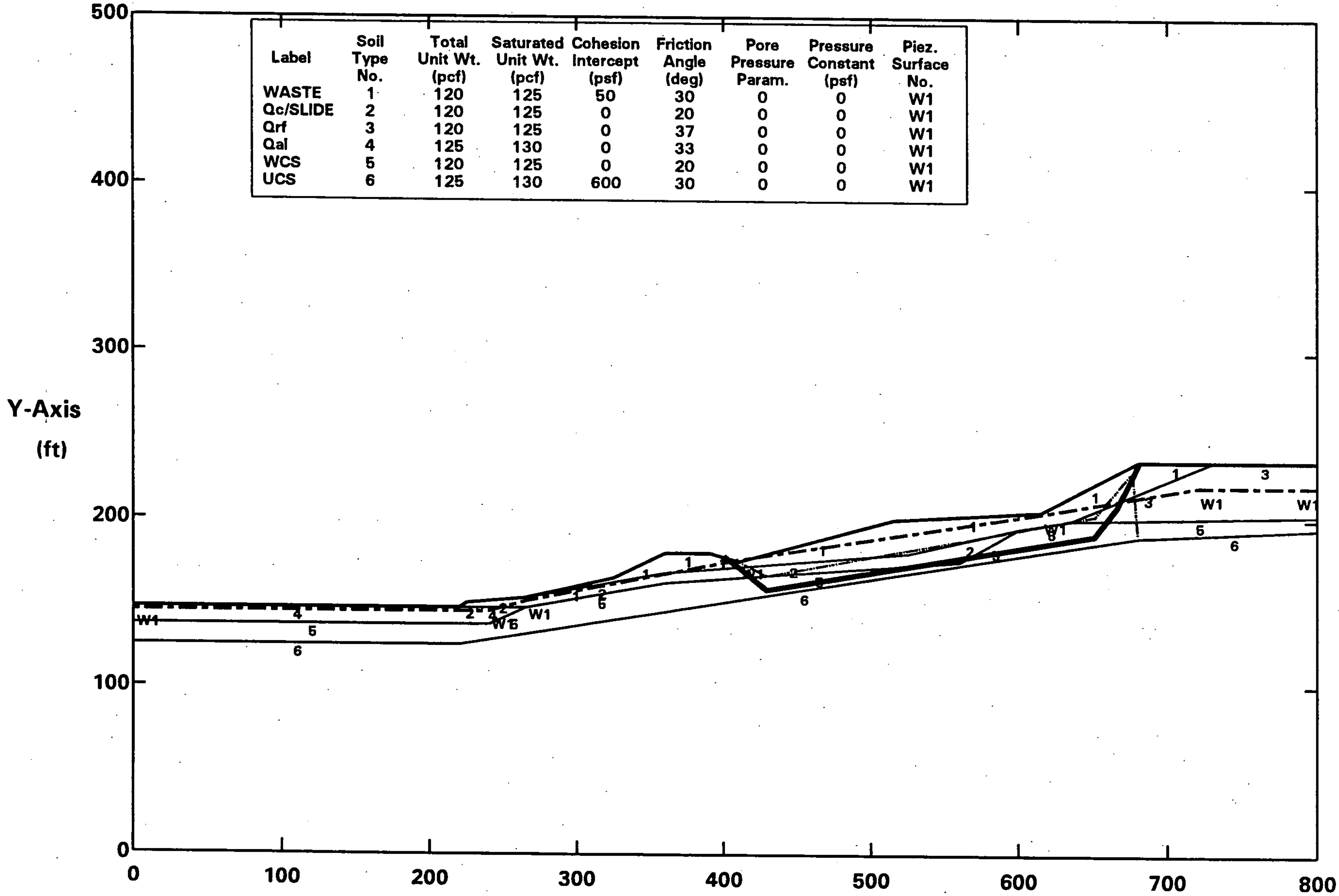
PCSTABL5M/SI FSmin = 1.40 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION B - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:BEASS.PLT By: STAN KLINE 10-22-04 1:53am



Factors Of Safety Calculated By The Modified Janbu Method

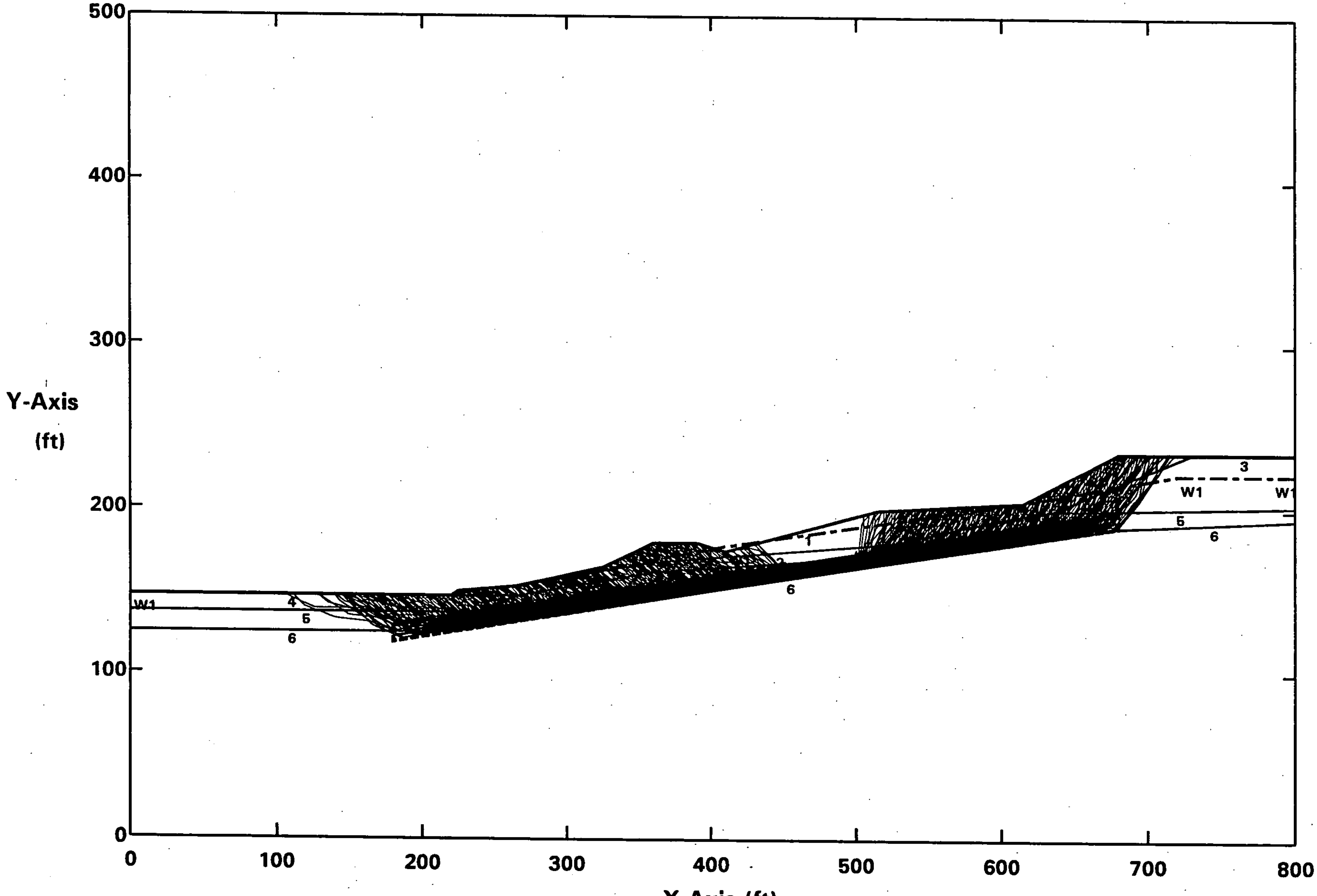
ROCKY FLATS OLF - M&E SECTION B - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-EASS.OUT. C:BEASSSP.PLT By: STAN KLINE 10-22-04 1:55am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

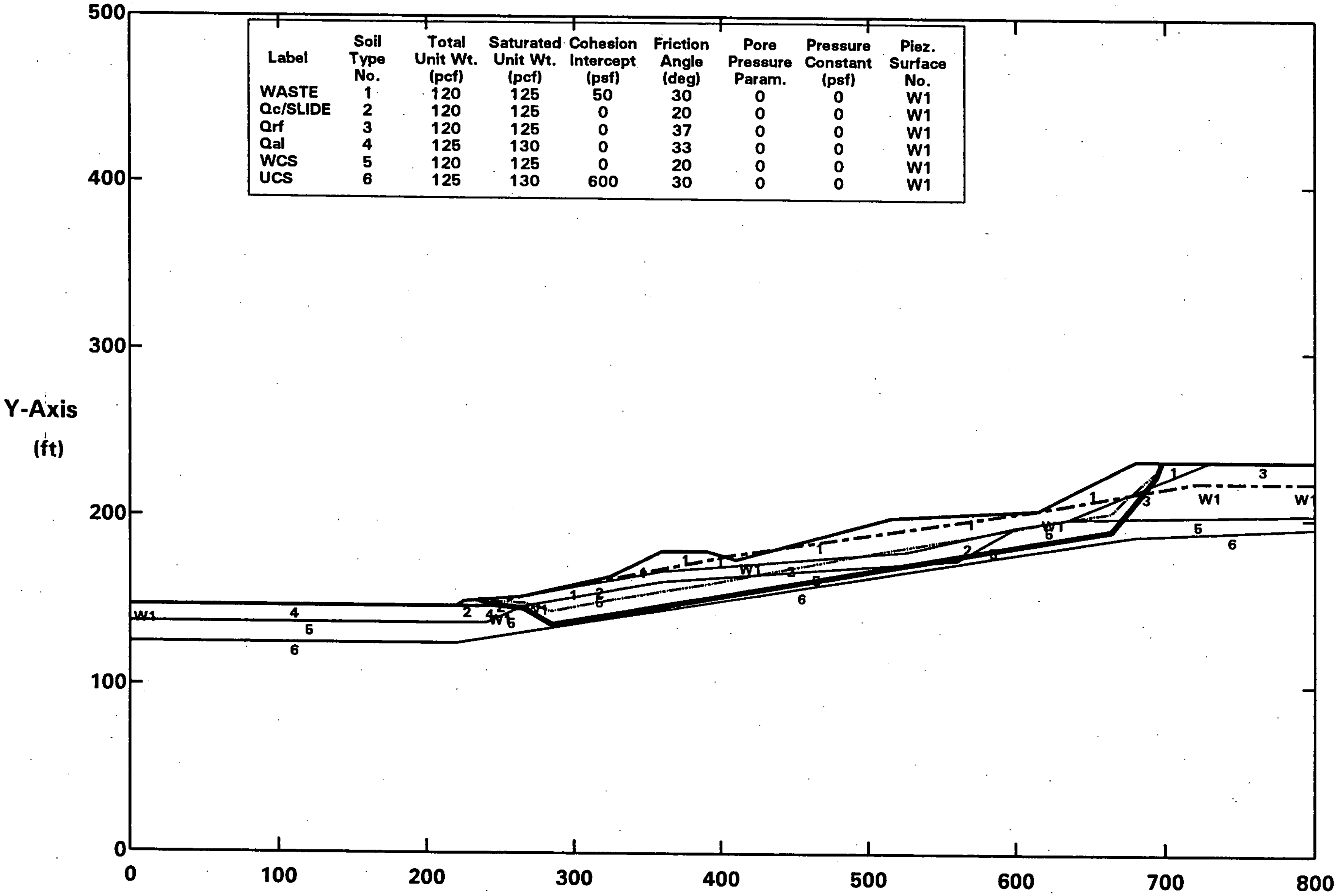
PCSTABL5M/SI FS=1.44 Theta=9.49 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E SECTION B - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:BEHSS.PLT By: STAN KLINE 10-23-04 7:03pm



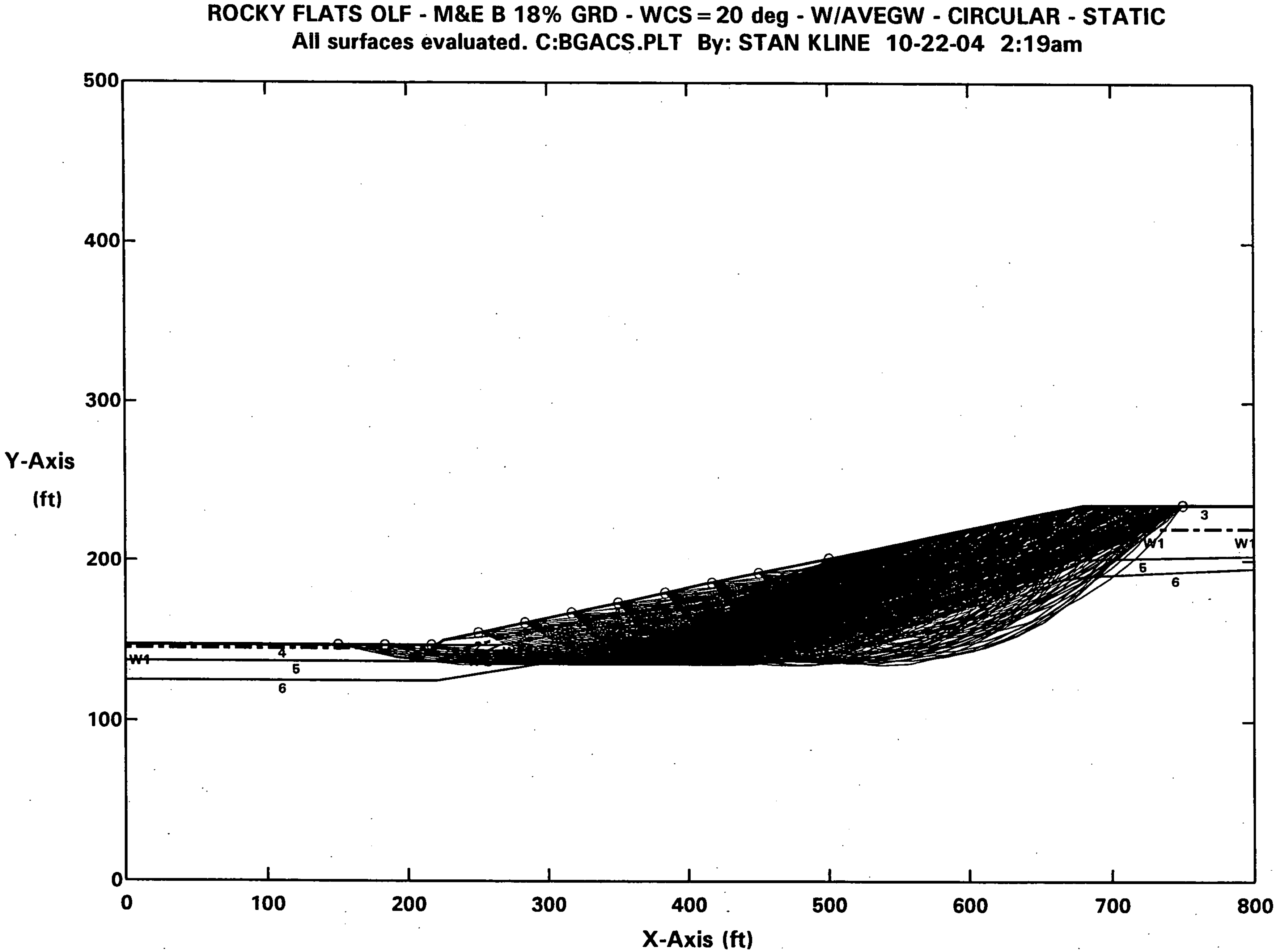
Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E SECTION B - WCS = 20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-EHSS.OUT. C:BEHSSSP.PLT By: STAN KLINE 10-22-04 1:27am



PCSTABL5M/SI FS = 1.33 Theta = 9.16 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

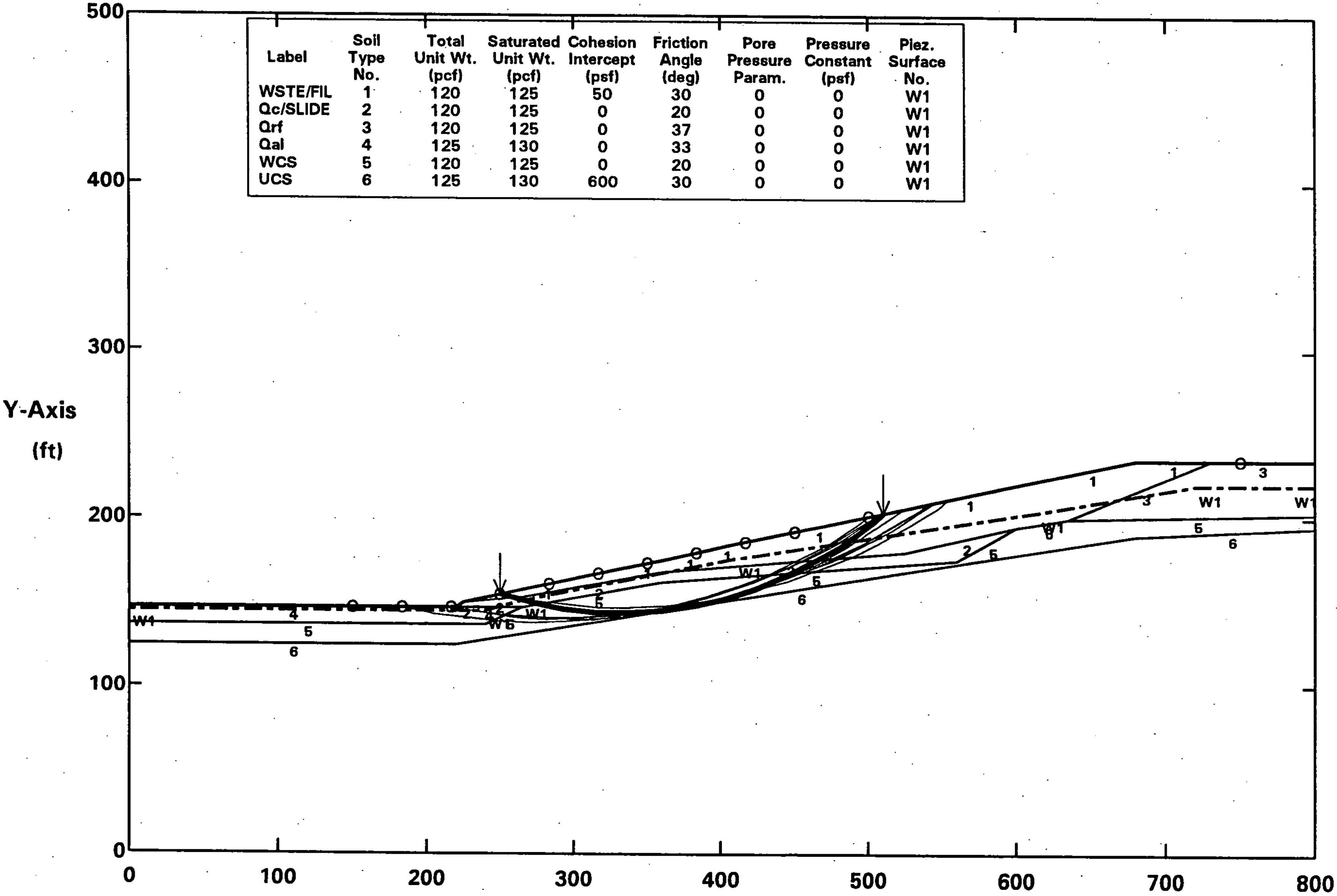
18% REGRADE CONDITION



Factors Of Safety Calculated By The Modified Bishop Method

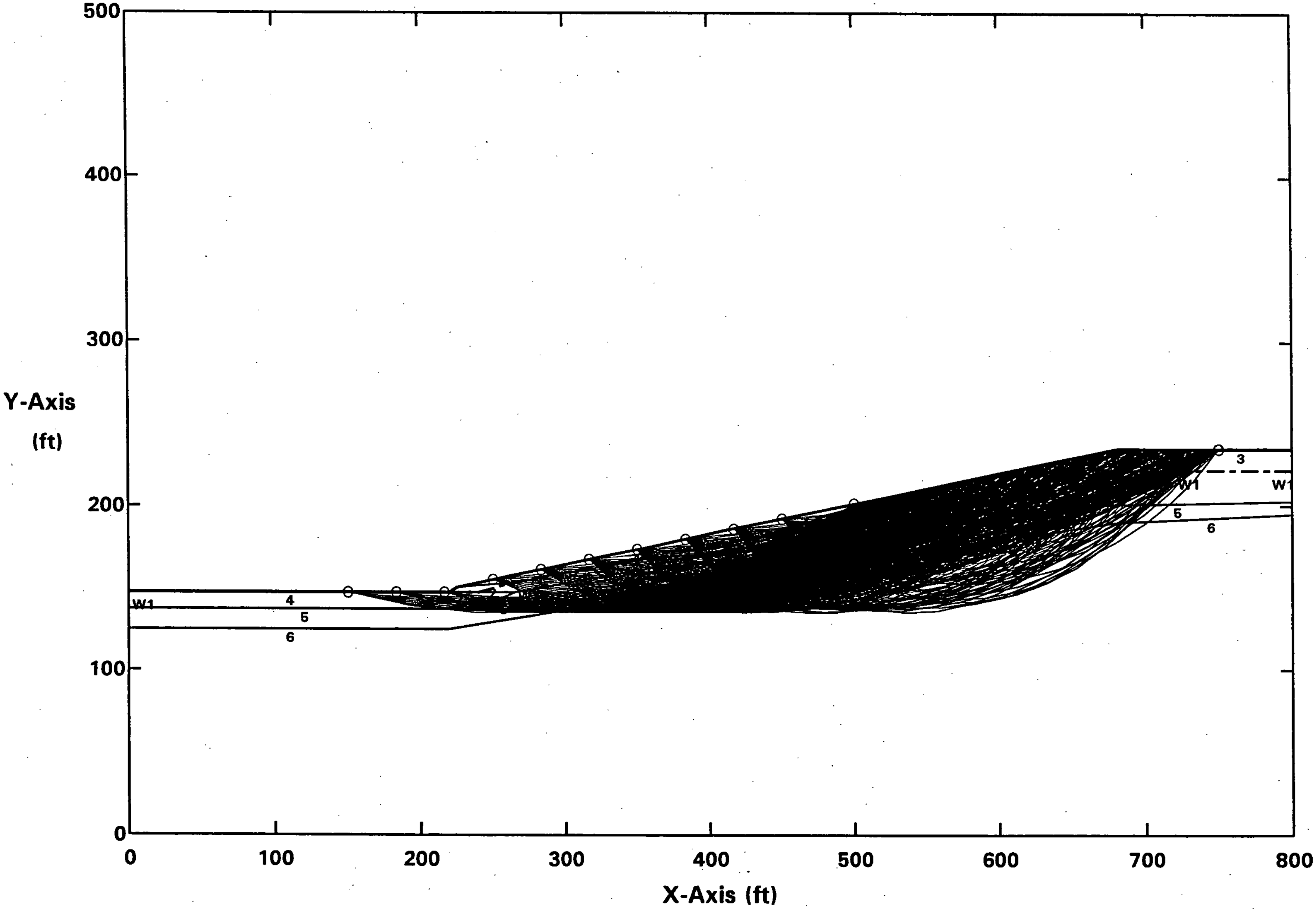
ROCKY FLATS OLF - M&E B 18% GRD - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:BGACS.PLT By: STAN KLINE 10-22-04 2:19am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1



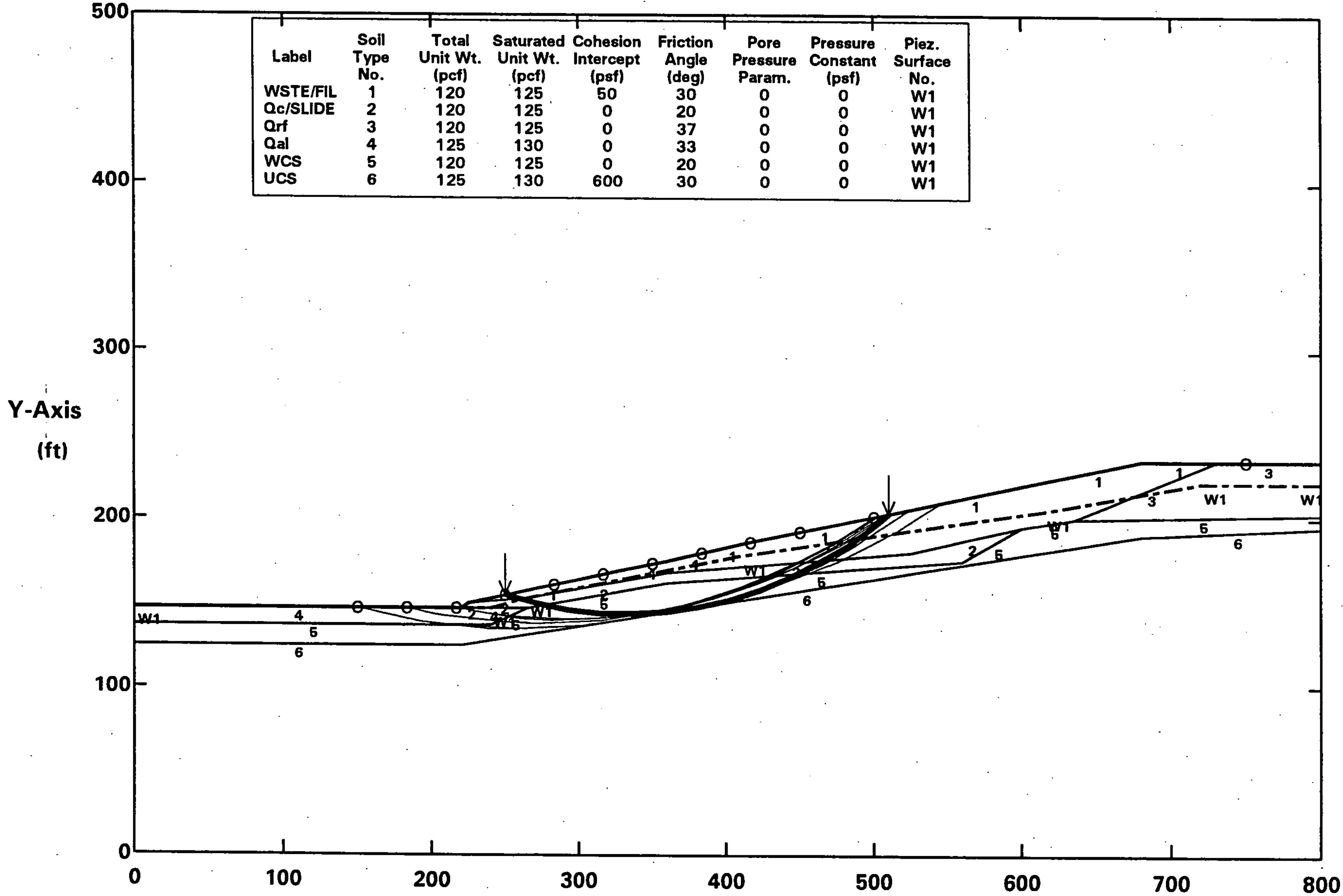
PCSTABL5M/SI FSmin = 1.57 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18% GRD - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:BGHCS.PLT By: STAN KLINE 10-25-04 12:10am



Factors Of Safety Calculated By The Modified Bishop Method

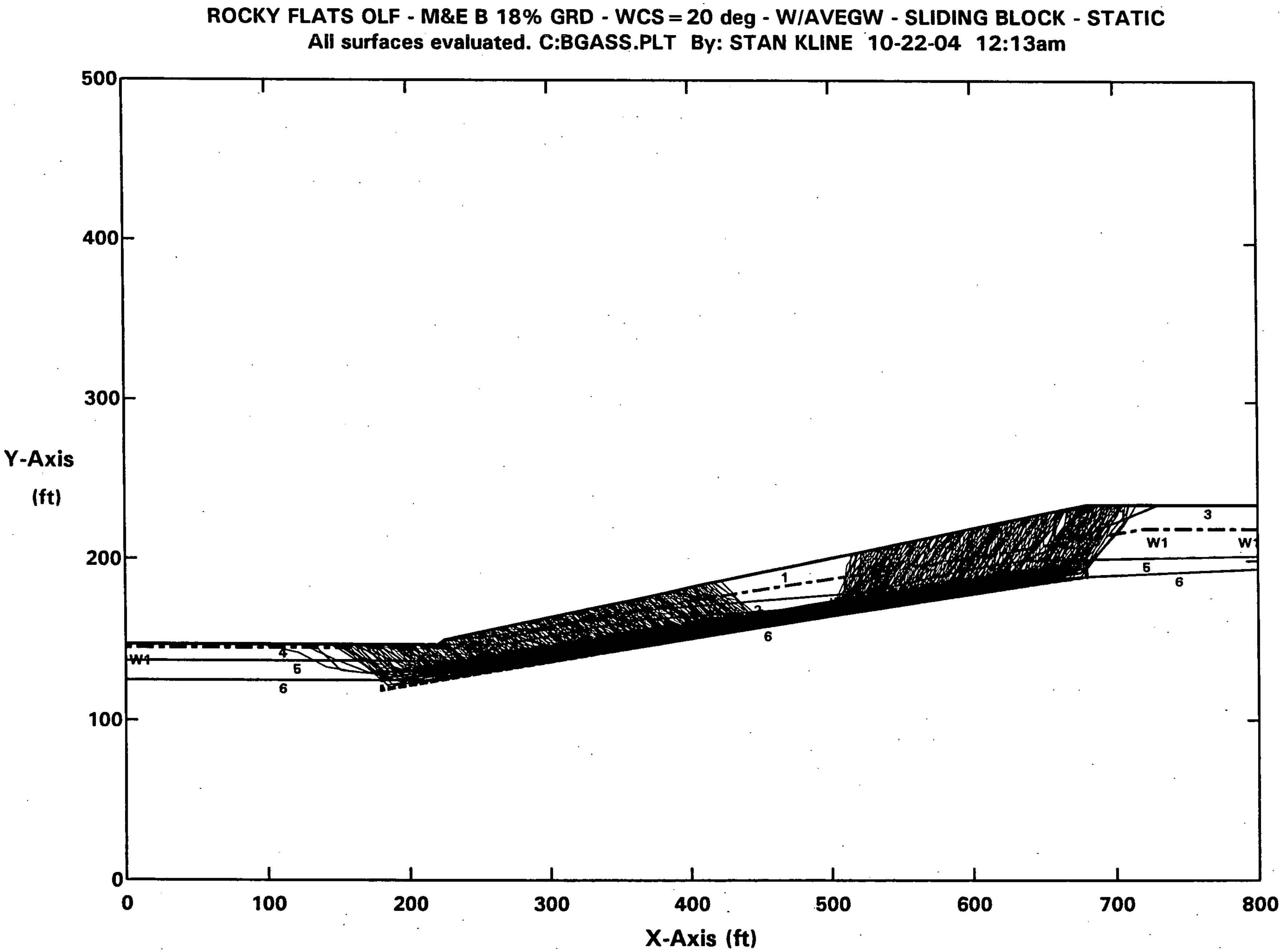
ROCKY FLATS OLF - M&E B 18% GRD - WCS=20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:BGHCS.PLT By: STAN KLINE 10-25-04 12:10am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

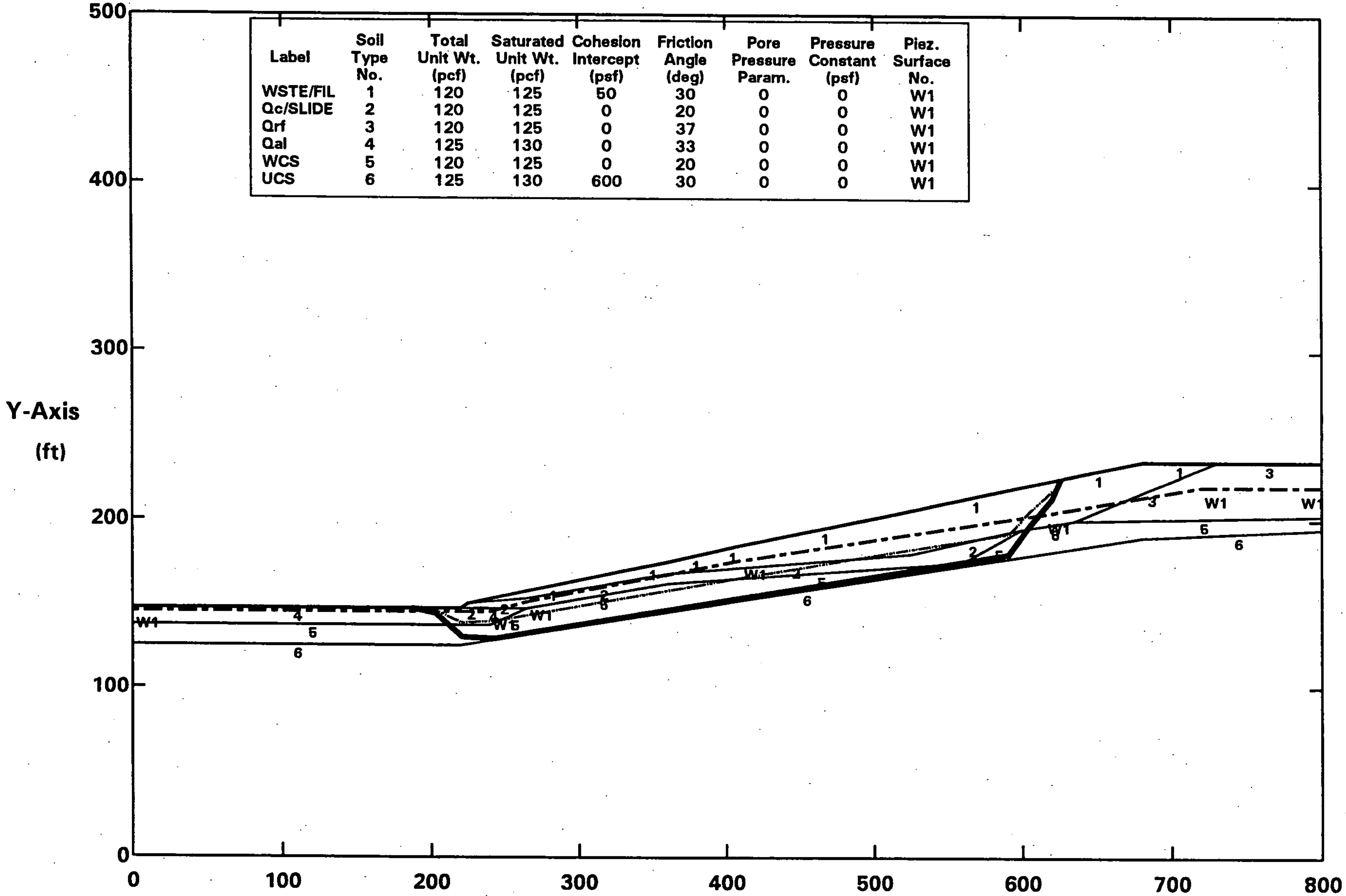
PCSTABL5M/SI FSmin=1.48 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method



Factors Of Safety Calculated By The Modified Janbu Method

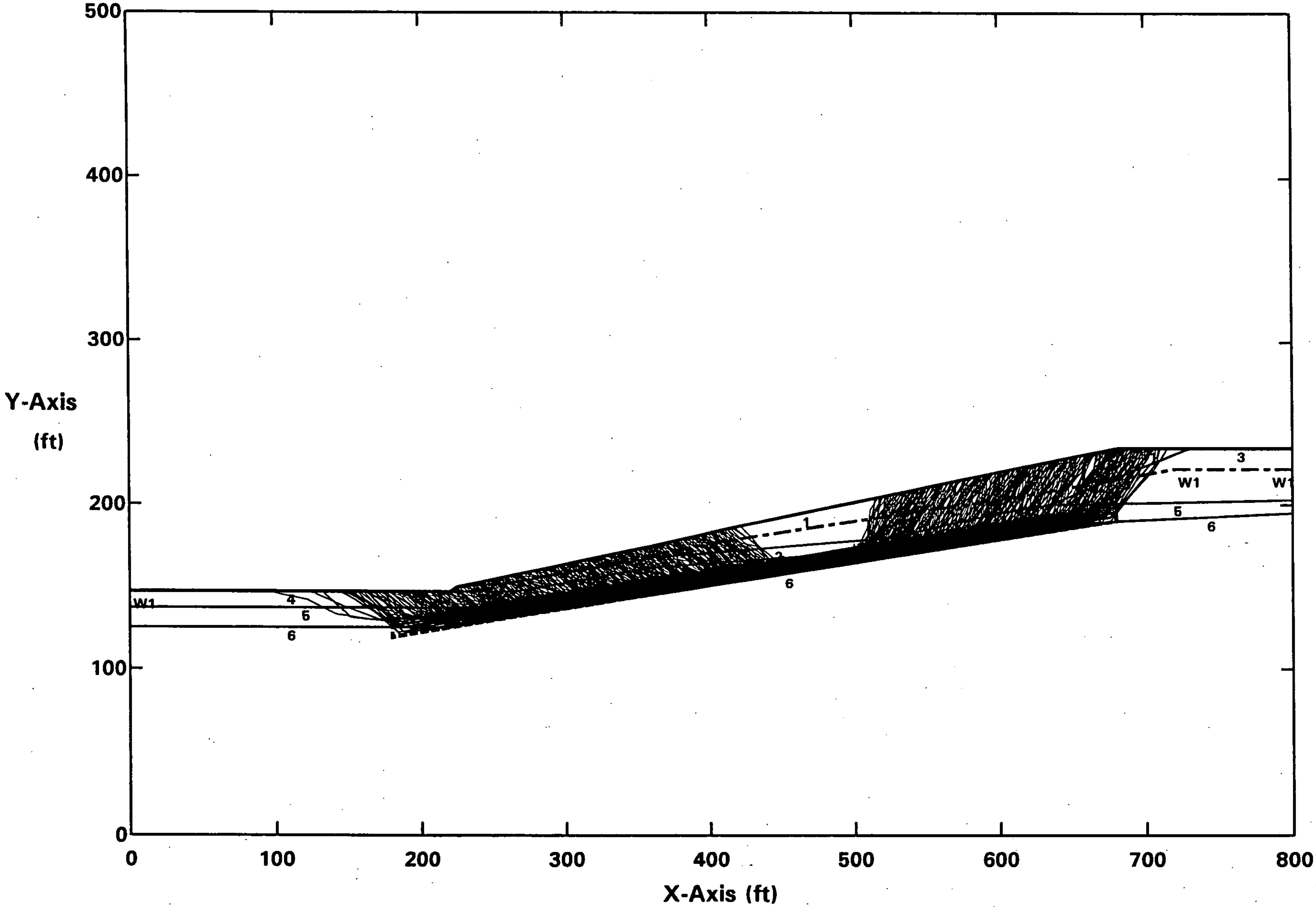
ROCKY FLATS OLF - M&E B 18% GRD - WCS = 20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-GASS.OUT. C:BGASSSP.PLT By: STAN KLINE 10-22-04 12:20am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

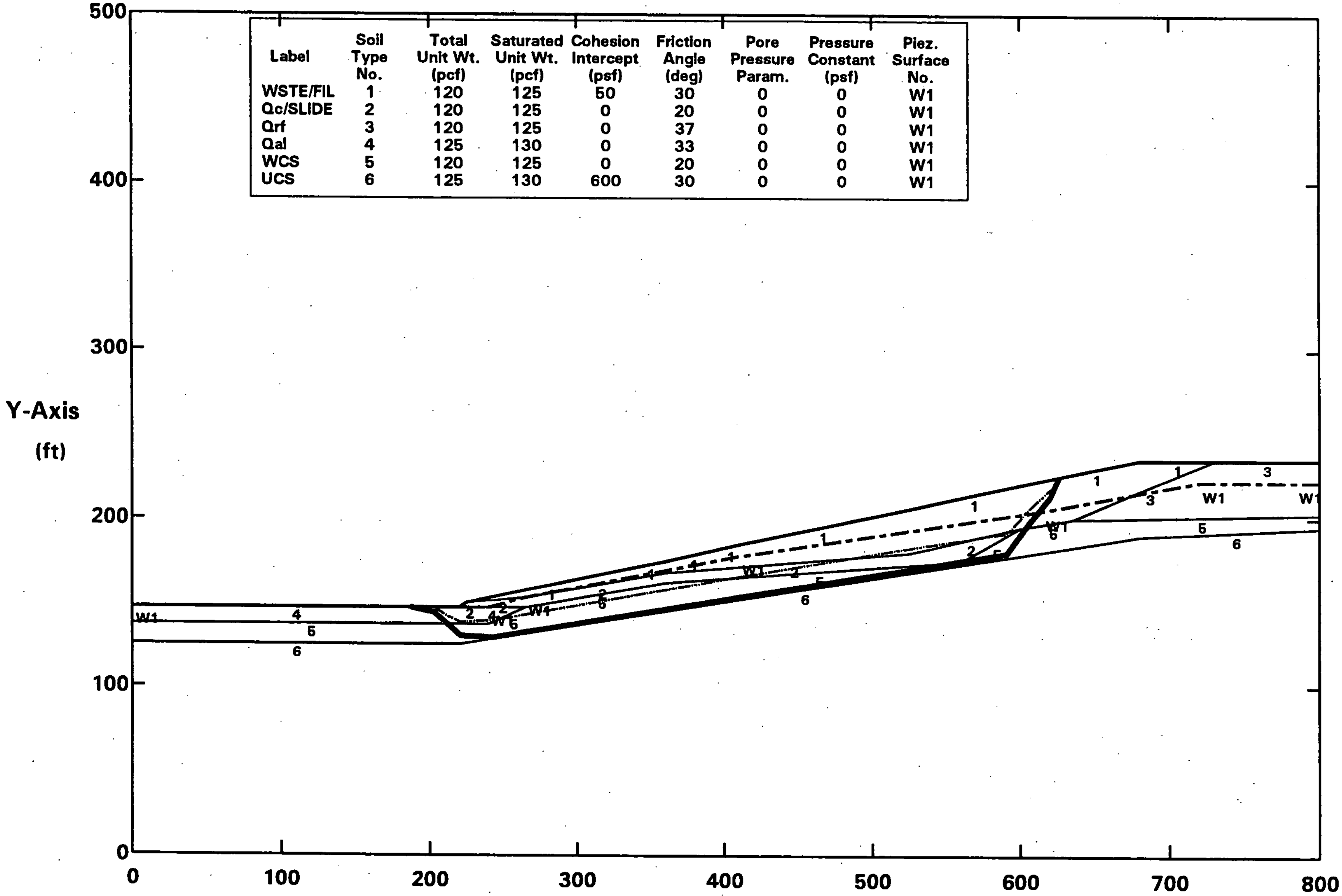
PCSTABL5M/SI FS = 1.57 Theta = 8.94 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E B 18% GRD - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:BGHSS.PLT By: STAN KLINE 10-25-04 12:14am



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E B 18% GRD - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-BGHSS.OUT. C:BGHSSSP.PLT By: STAN KLINE 10-25-04 12:15am

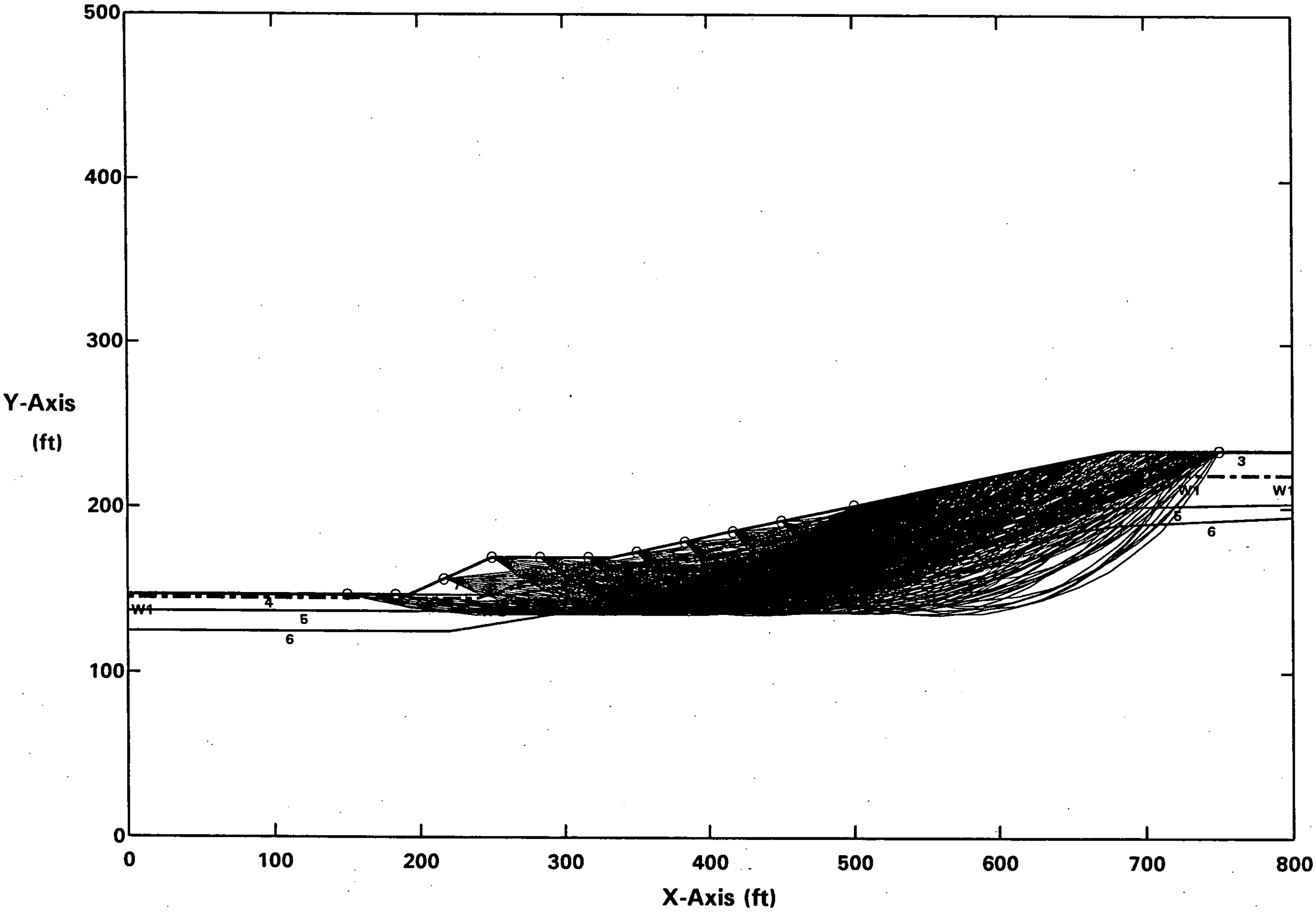


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS=1.50 Theta=8.98 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

18% REGRADE WITH BUTTRESS CONDITION

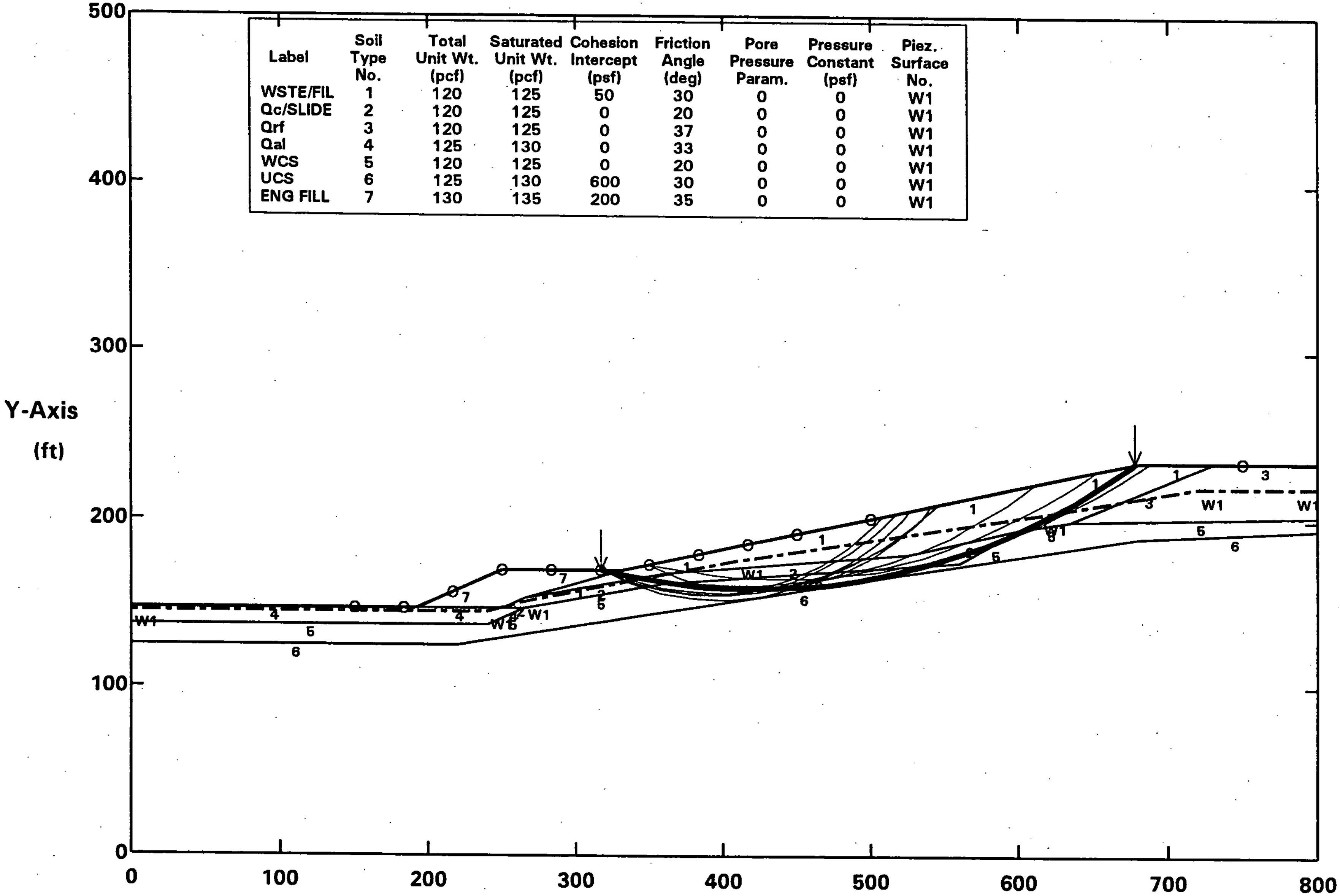
ROCKY FLATS OLF - M&E B 18%W/BM - WCS=20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:BBACS.PLT By: STAN KLINE 10-22-04 2:26am



Factors Of Safety Calculated By The Modified Bishop Method

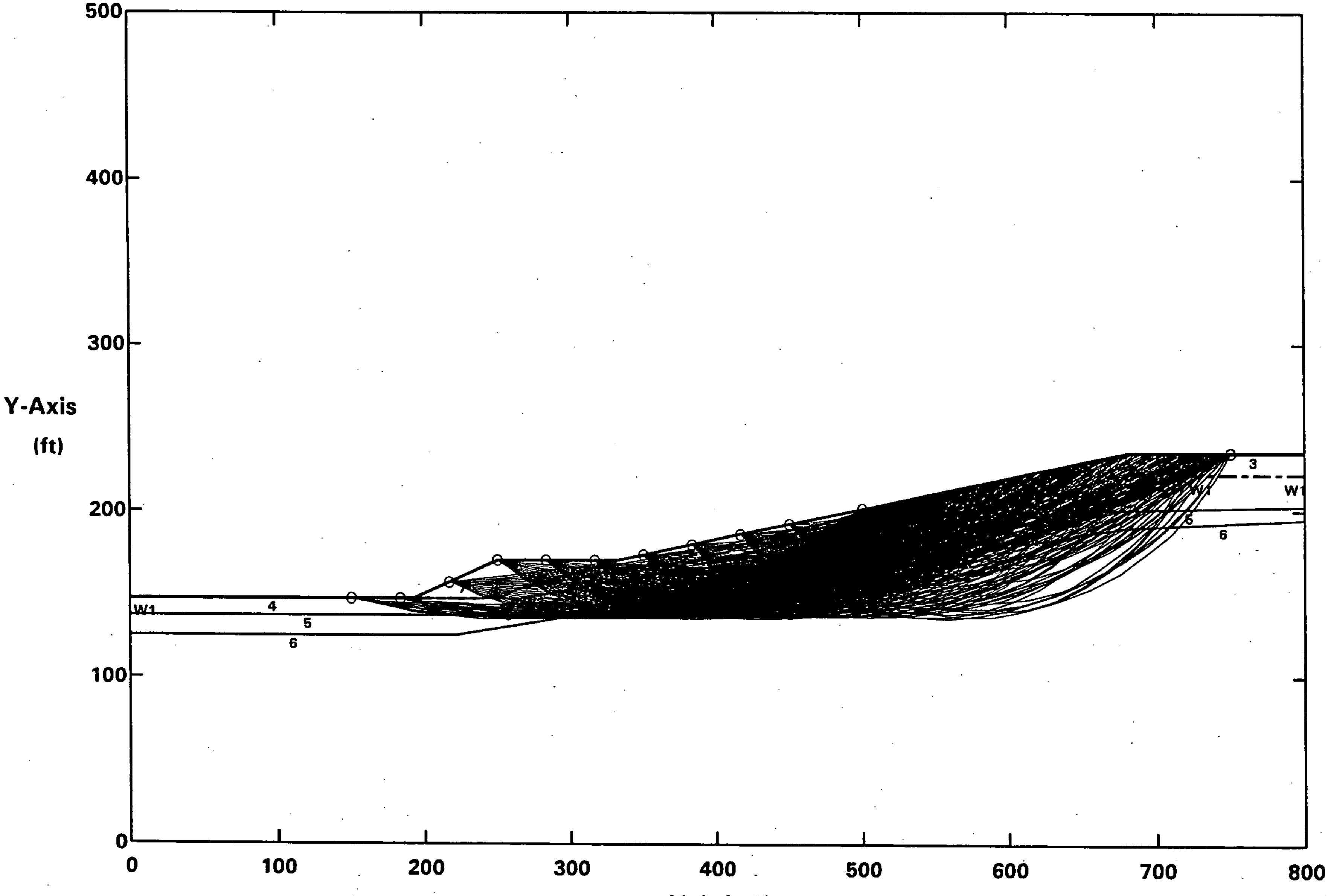
ROCKY FLATS OLF - M&E B 18%W/BM - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:BBACS.PLT By: STAN KLINE 10-22-04 2:26am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1



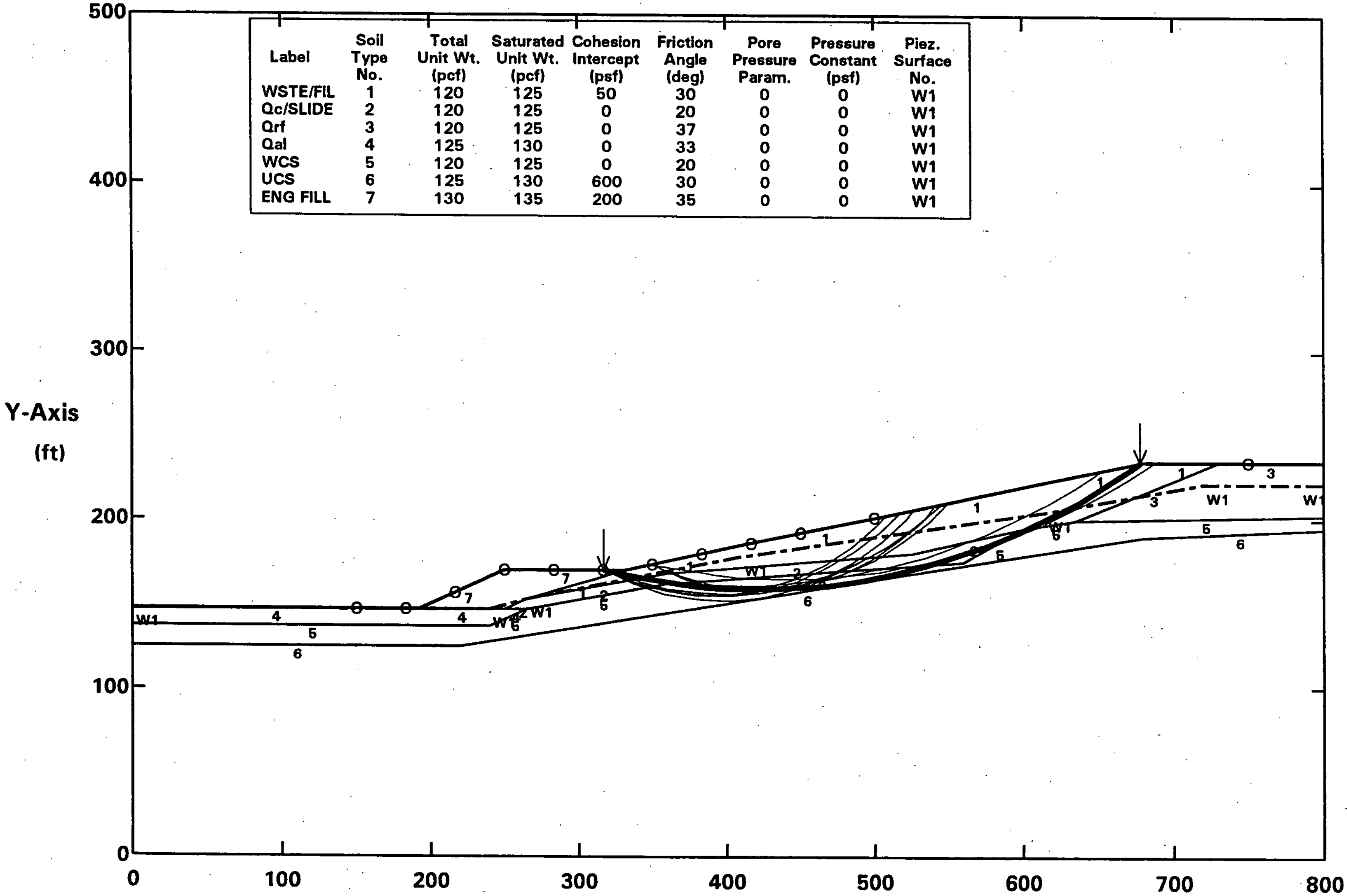
PCSTABL5M/SI FSmin = 1.72 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS=20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:BBHCS.PLT By: STAN KLINE 10-22-04 2:42am



Factors Of Safety Calculated By The Modified Bishop Method

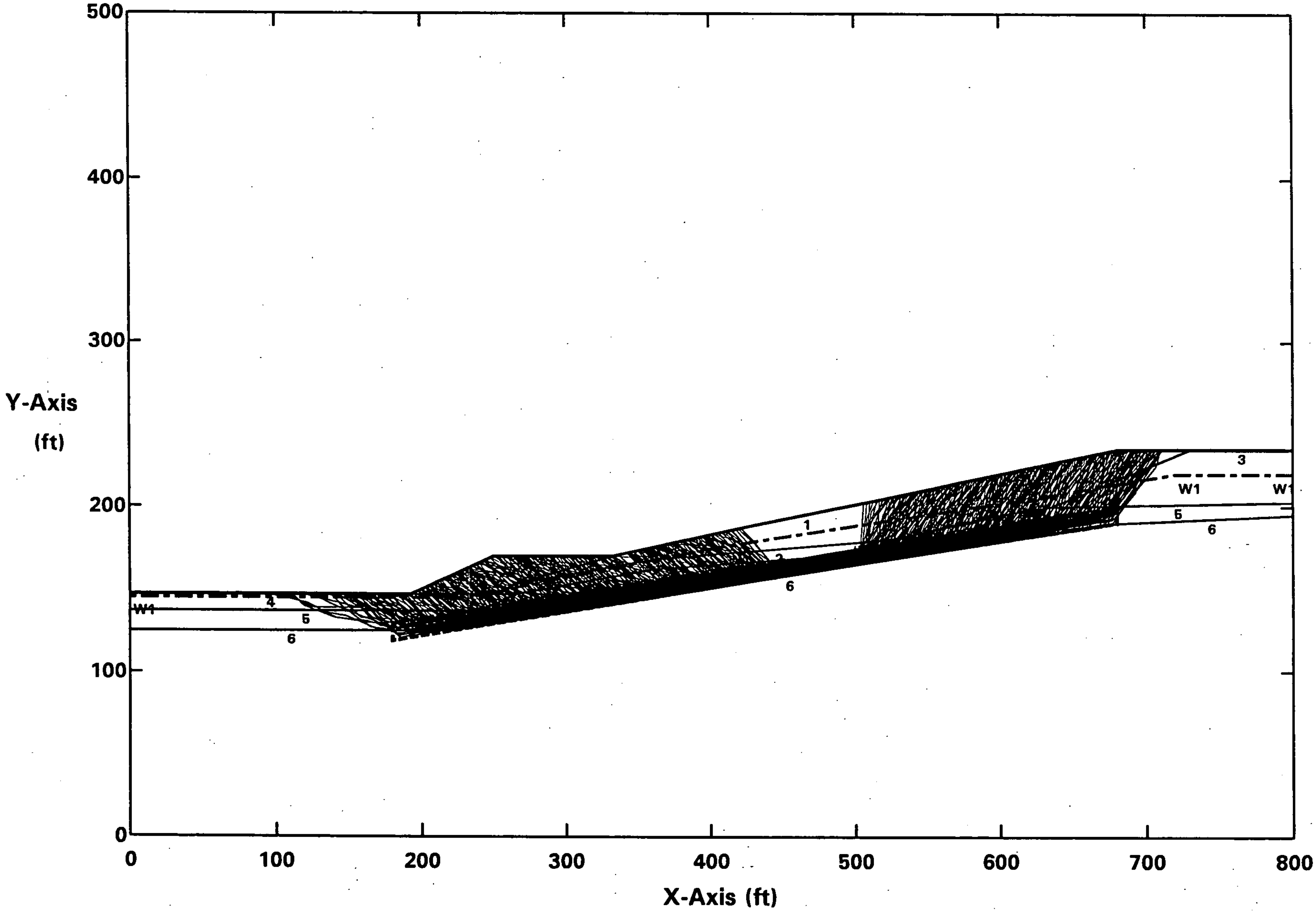
ROCKY FLATS OLF - M&E B 18%W/BM - WCS=20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:BBHCS.PLT By: STAN KLINE 10-22-04 2:42am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FSmin=1.66 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

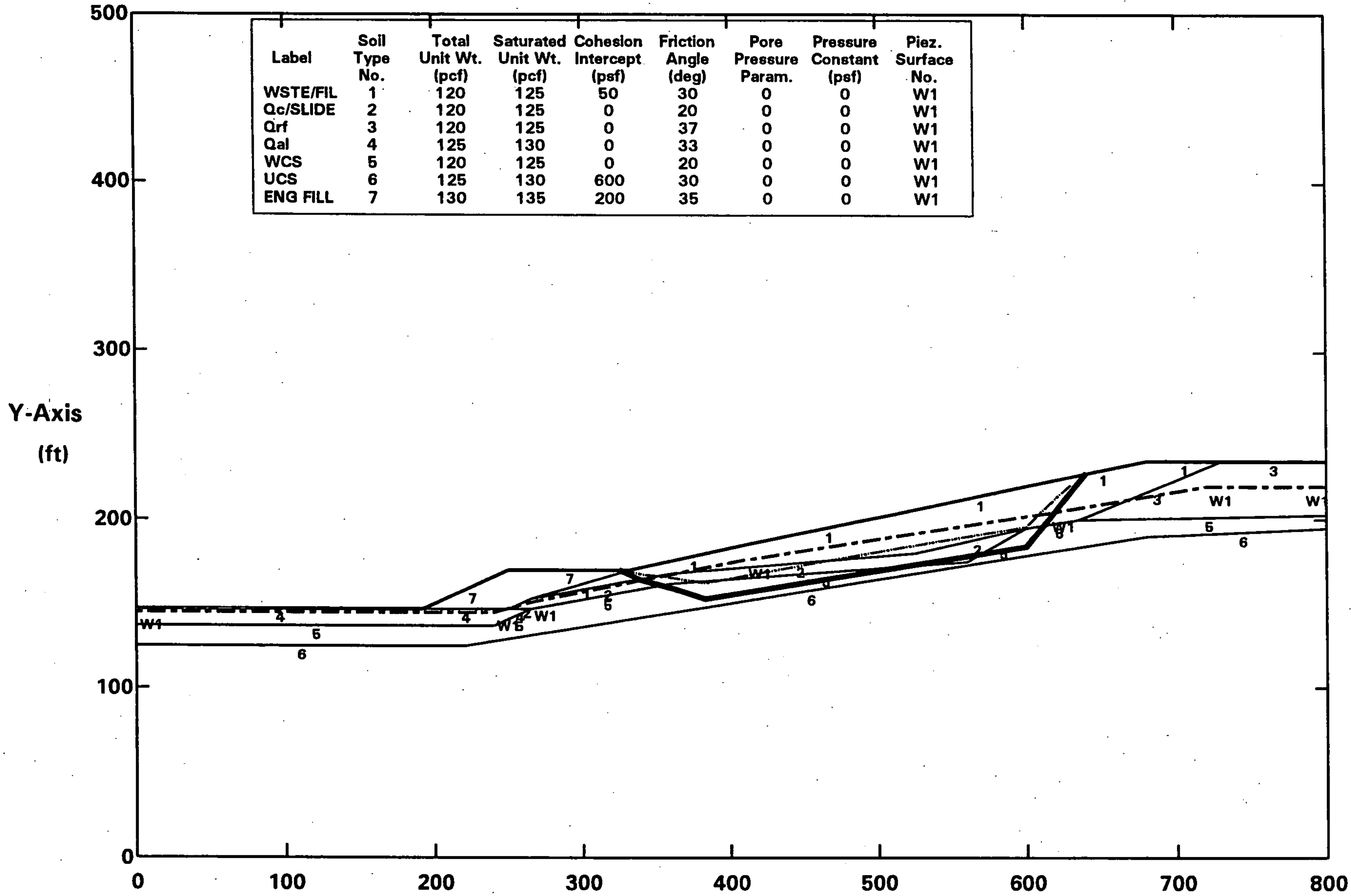
ROCKY FLATS OLF - M&E B 18%W/BM - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:BBASS.PLT By: STAN KLINE 10-22-04 2:03am



Factors Of Safety Calculated By The Modified Janbu Method

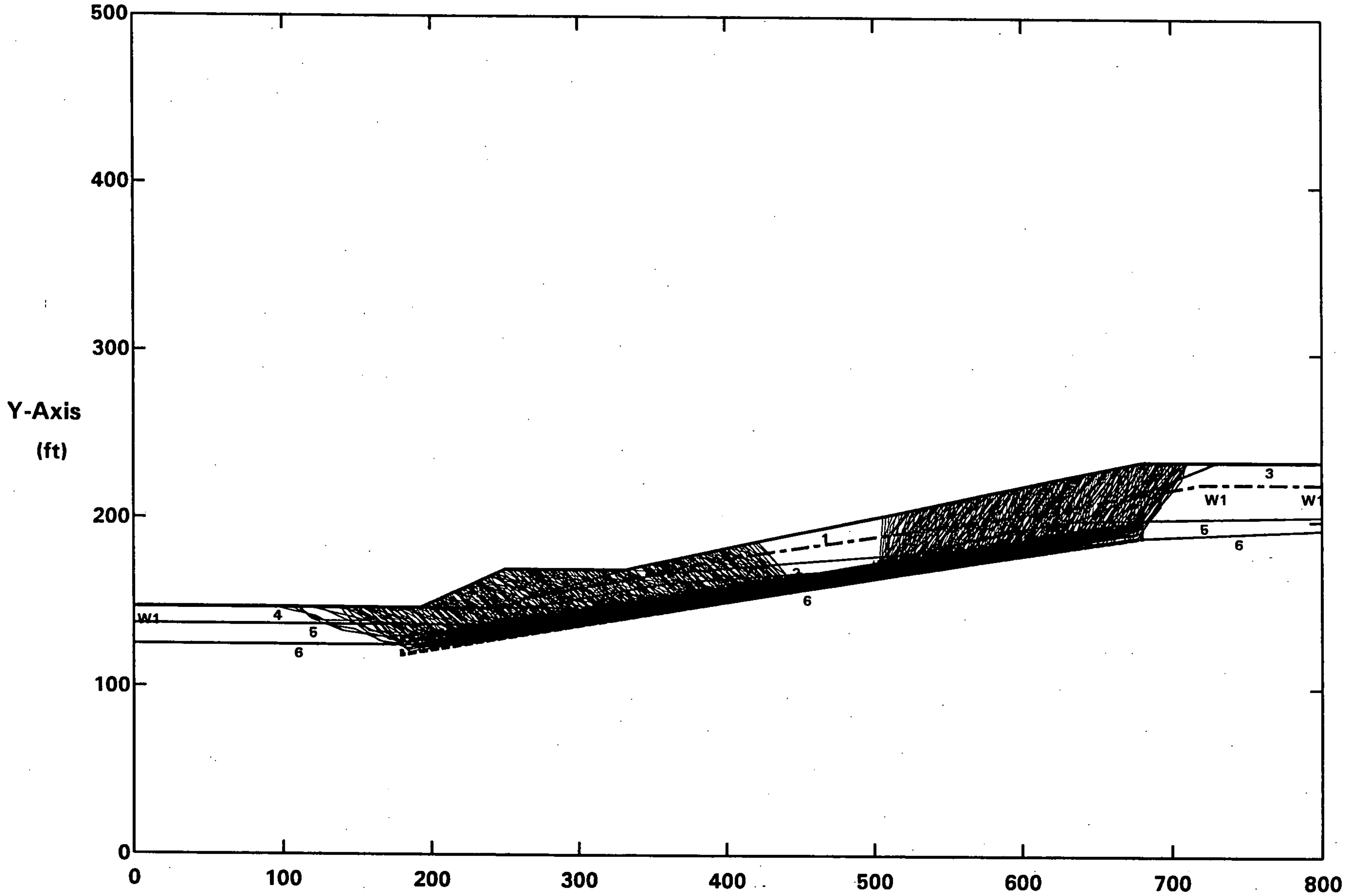
ROCKY FLATS OLF - M&E B 18%W/BM - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-BASS.OUT. C:BBASSSP.PLT By: STAN KLINE 10-22-04 2:05am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1



PCSTABL5M/SI FS=1.71 Theta=8.92 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

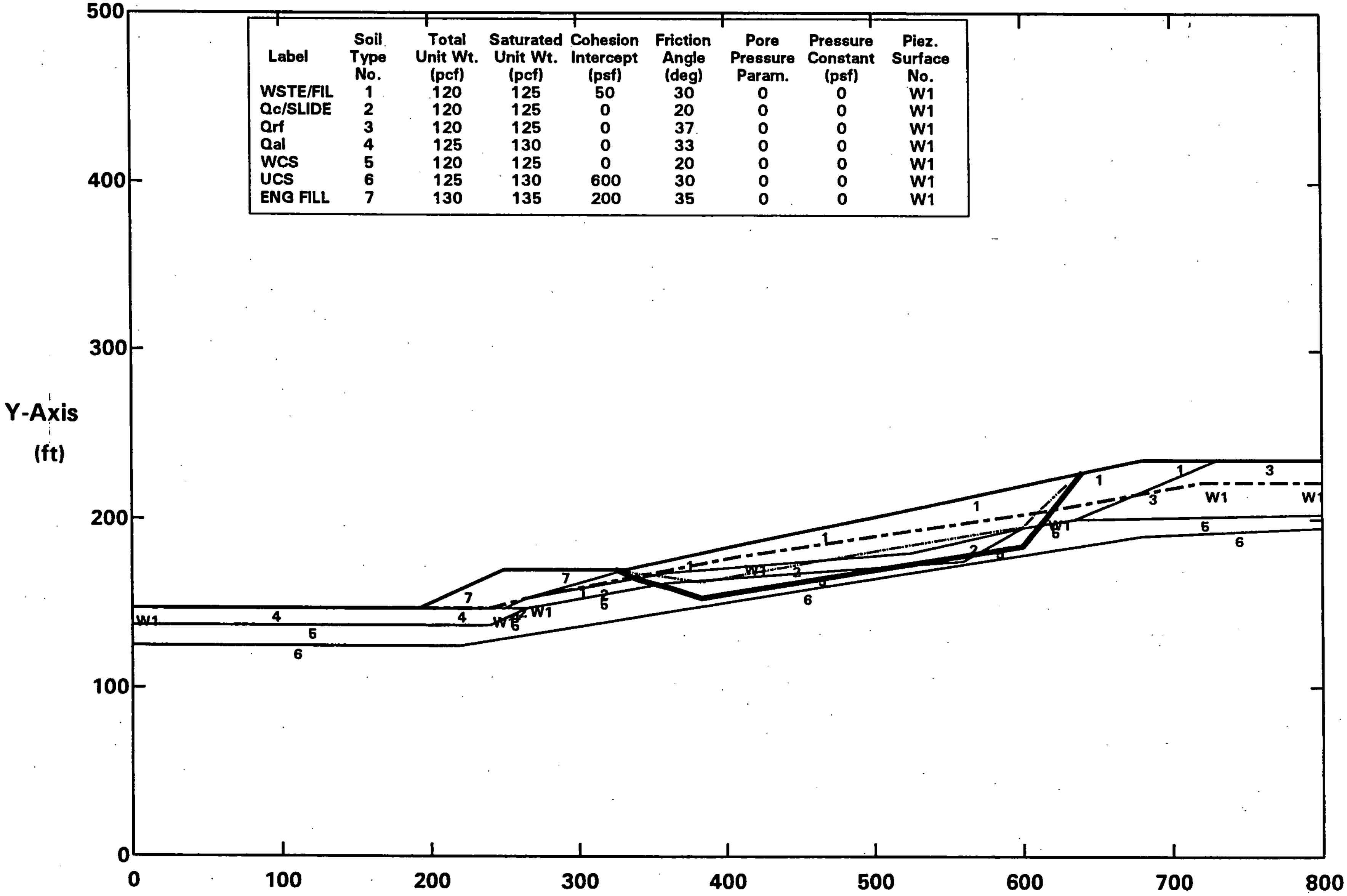
ROCKY FLATS OLF - M&E B 18%W/BM - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:BBHSS.PLT By: STAN KLINE 10-22-04 1:35am



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-BHSS.OUT. C:BBHSSSP.PLT By: STAN KLINE 10-22-04 1:37am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

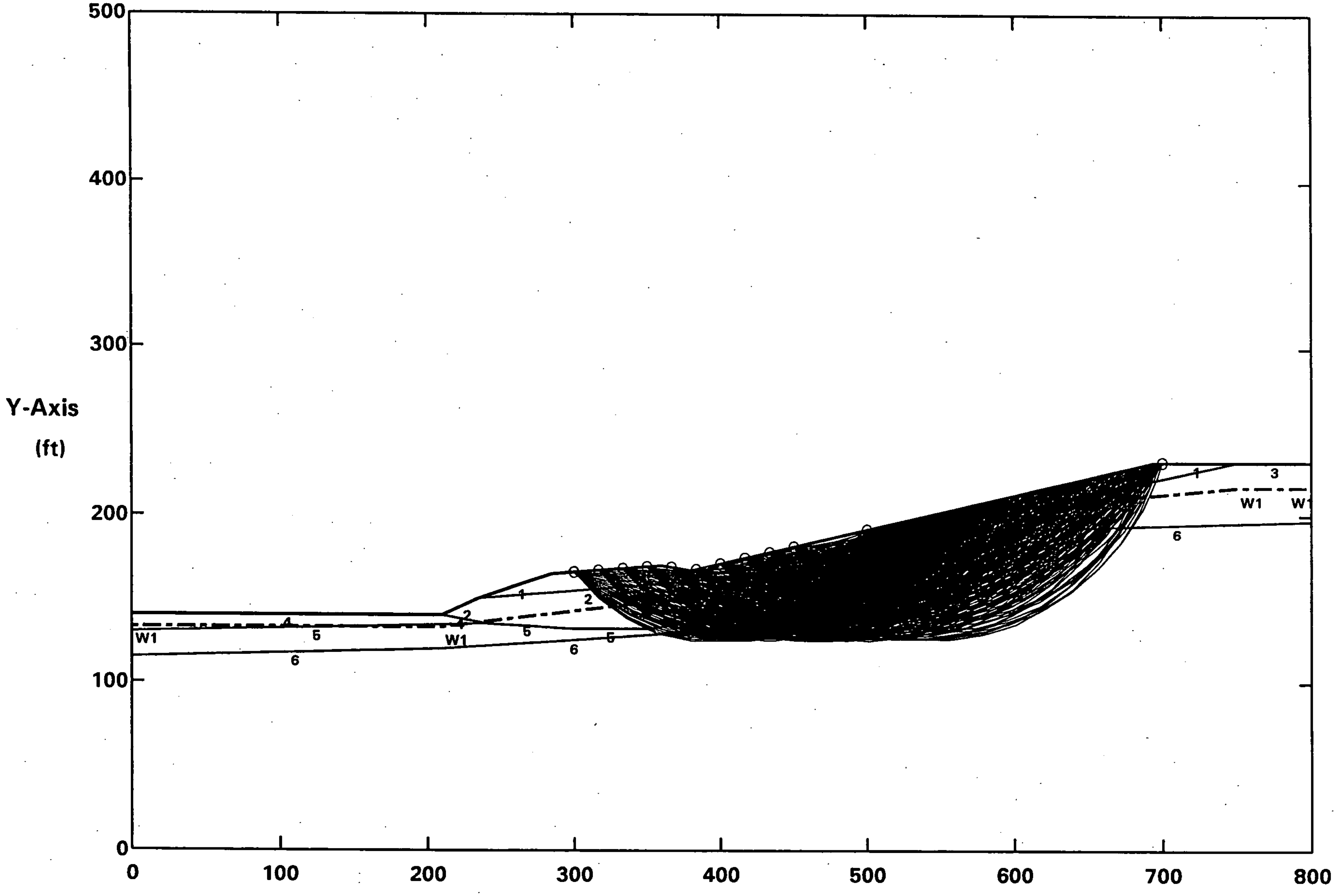


PCSTABL5M/SI FS=1.65 Theta=8.87 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

M&E SECTION C-C' – STATIC

EXISTING CONDITIONS

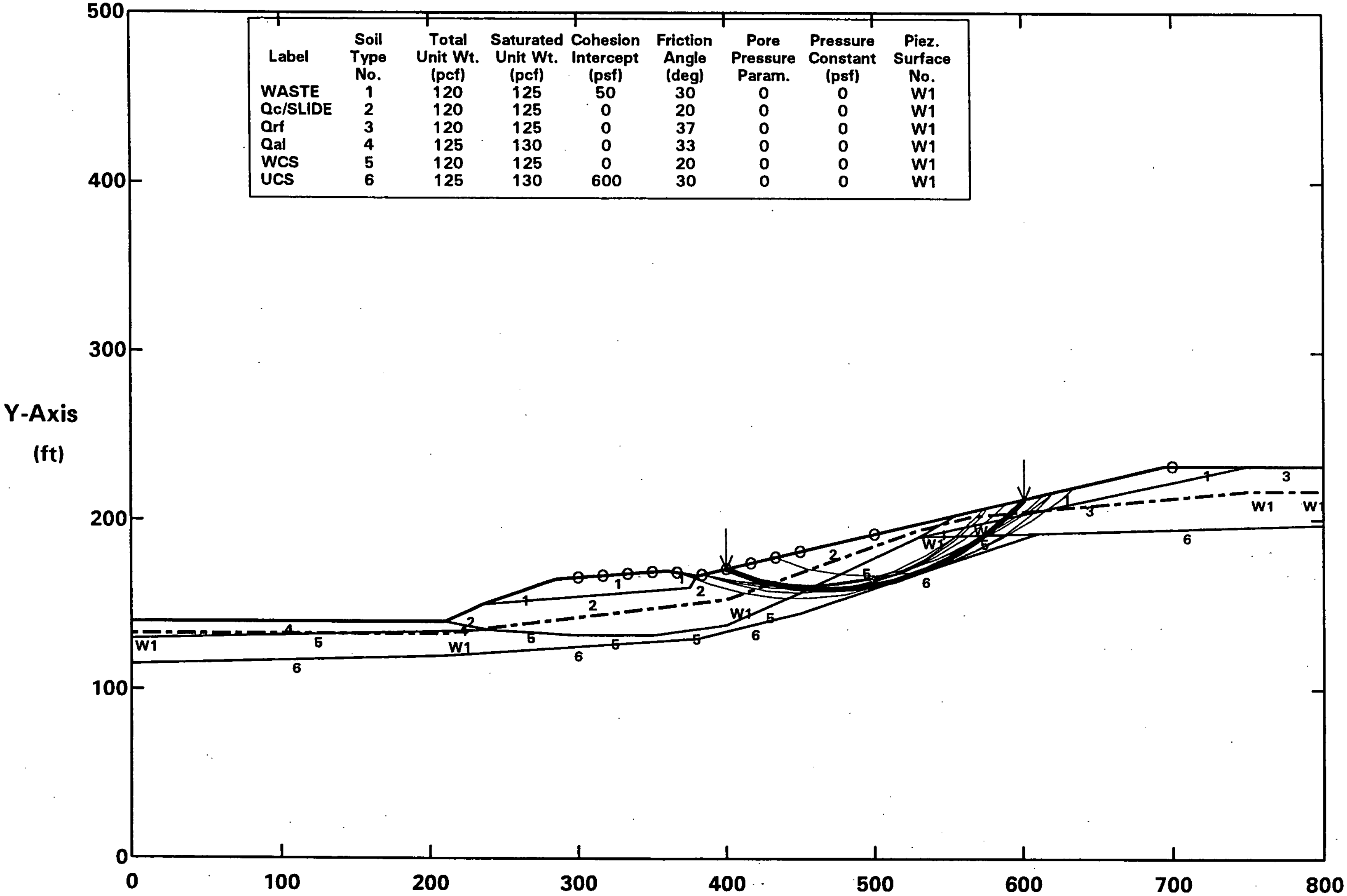
ROCKY FLATS OLF - M&E SECTION C - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:CEACS.PLT By: STAN KLINE 10-23-04 10:18pm



Factors Of Safety Calculated By The Modified Bishop Method

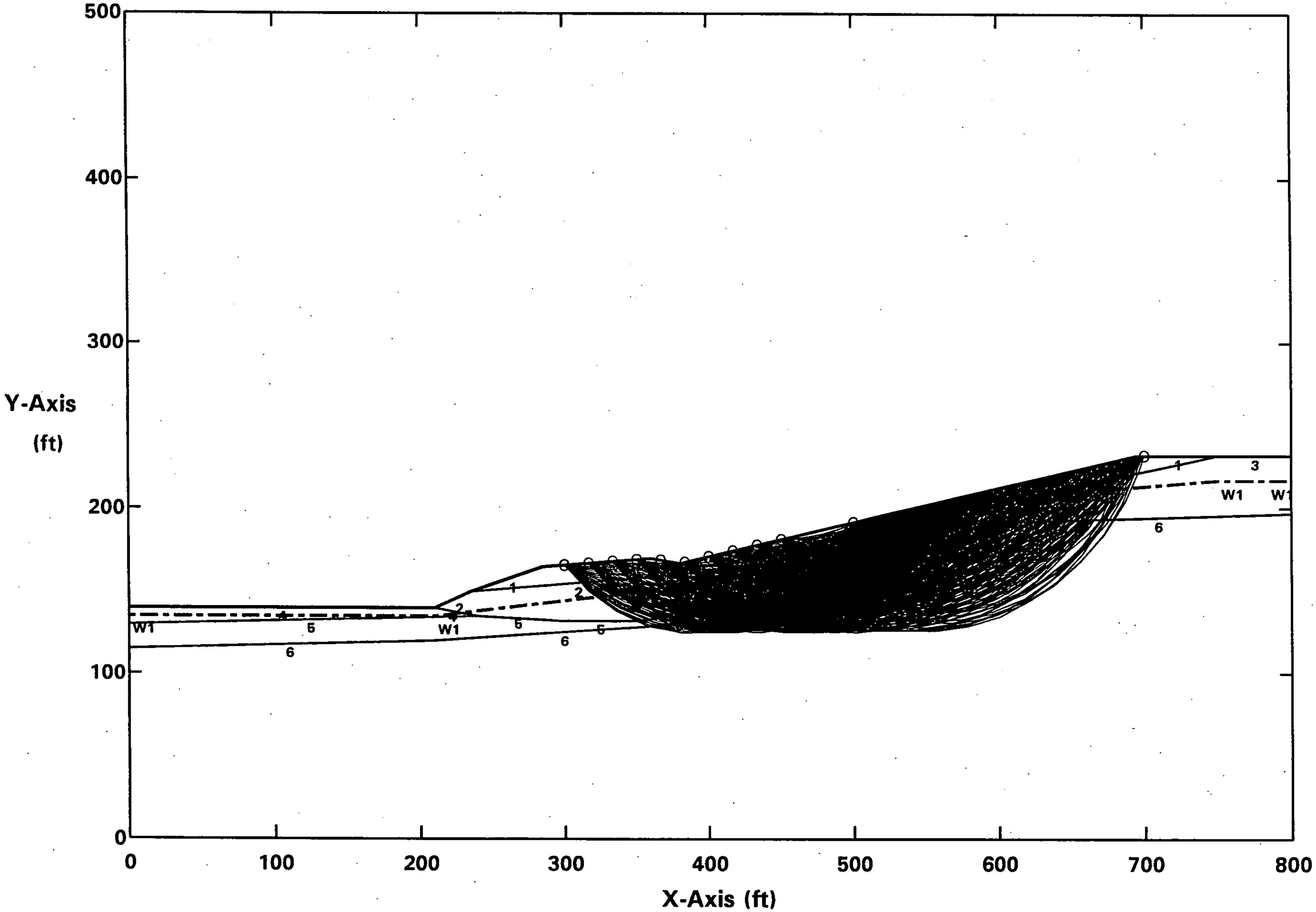
ROCKY FLATS OLF - M&E SECTION C - WCS=20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:CEACS.PLT By: STAN KLINE 10-23-04 10:18pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1



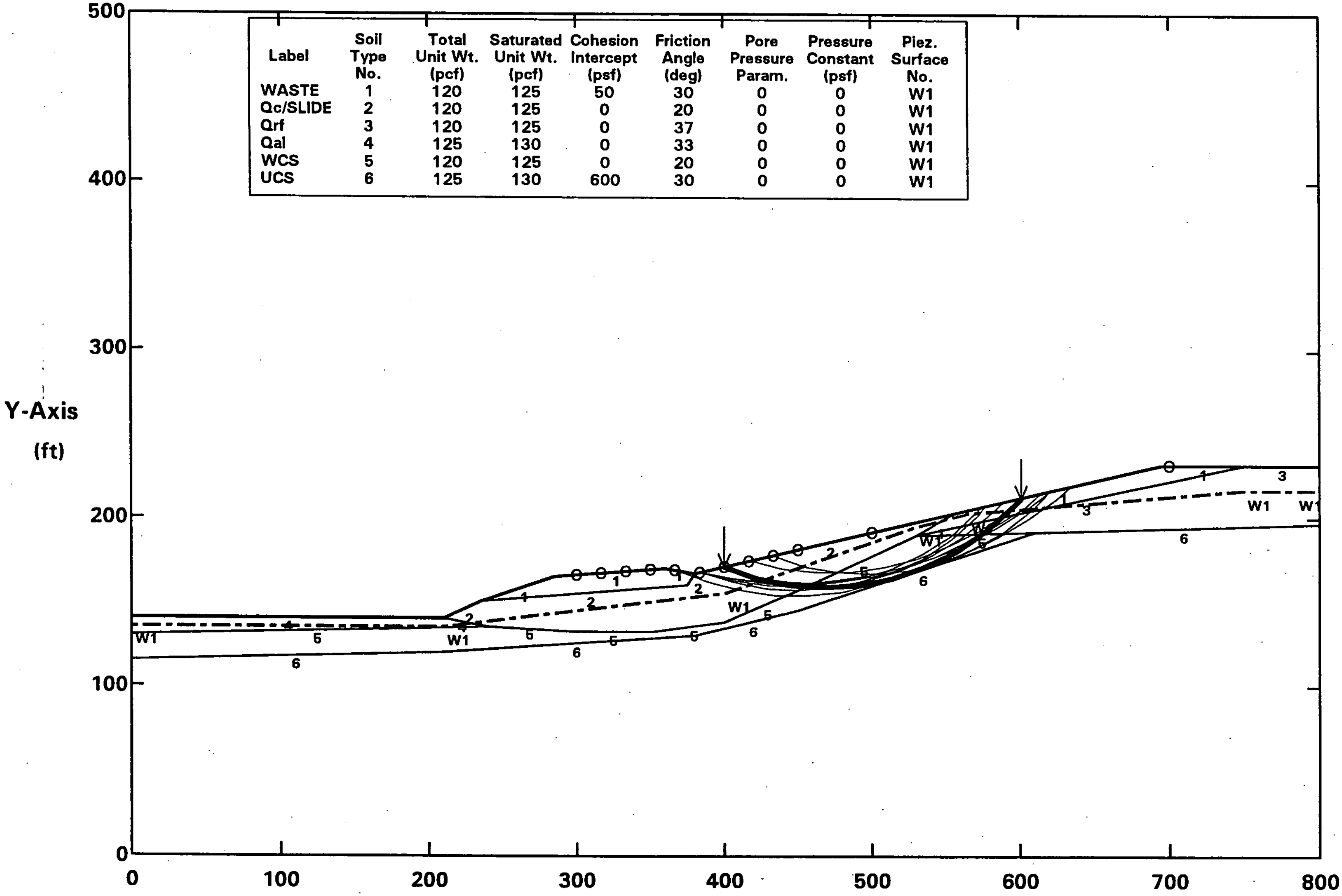
PCSTABL5M/SI FSmin=1.42 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION C - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:CEHCS.PLT By: STAN KLINE 10-23-04 9:37pm



Factors Of Safety Calculated By The Modified Bishop Method

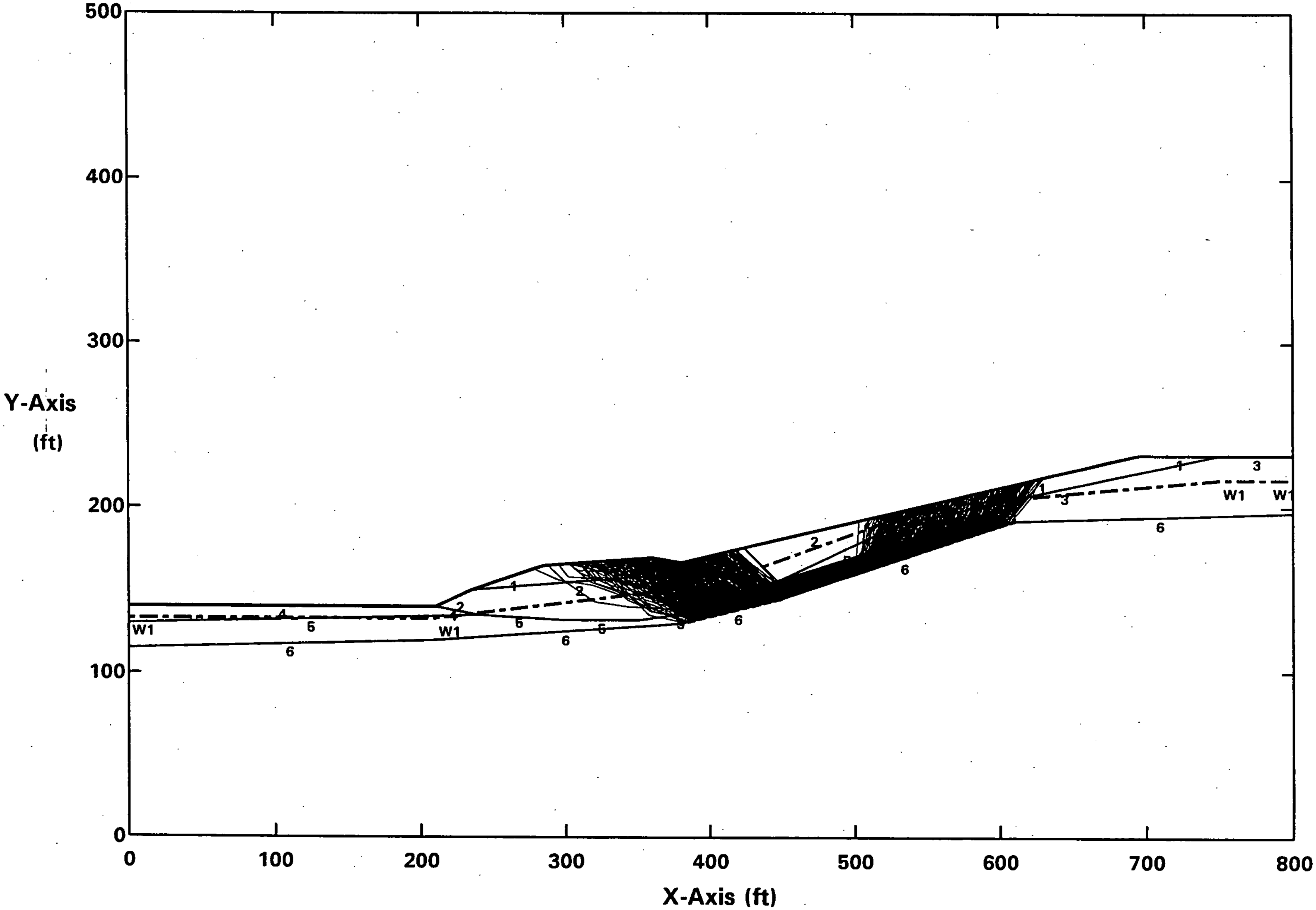
ROCKY FLATS OLF - M&E SECTION C - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:CEHCS.PLT By: STAN KLINE 10-23-04 9:37pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 1.37 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

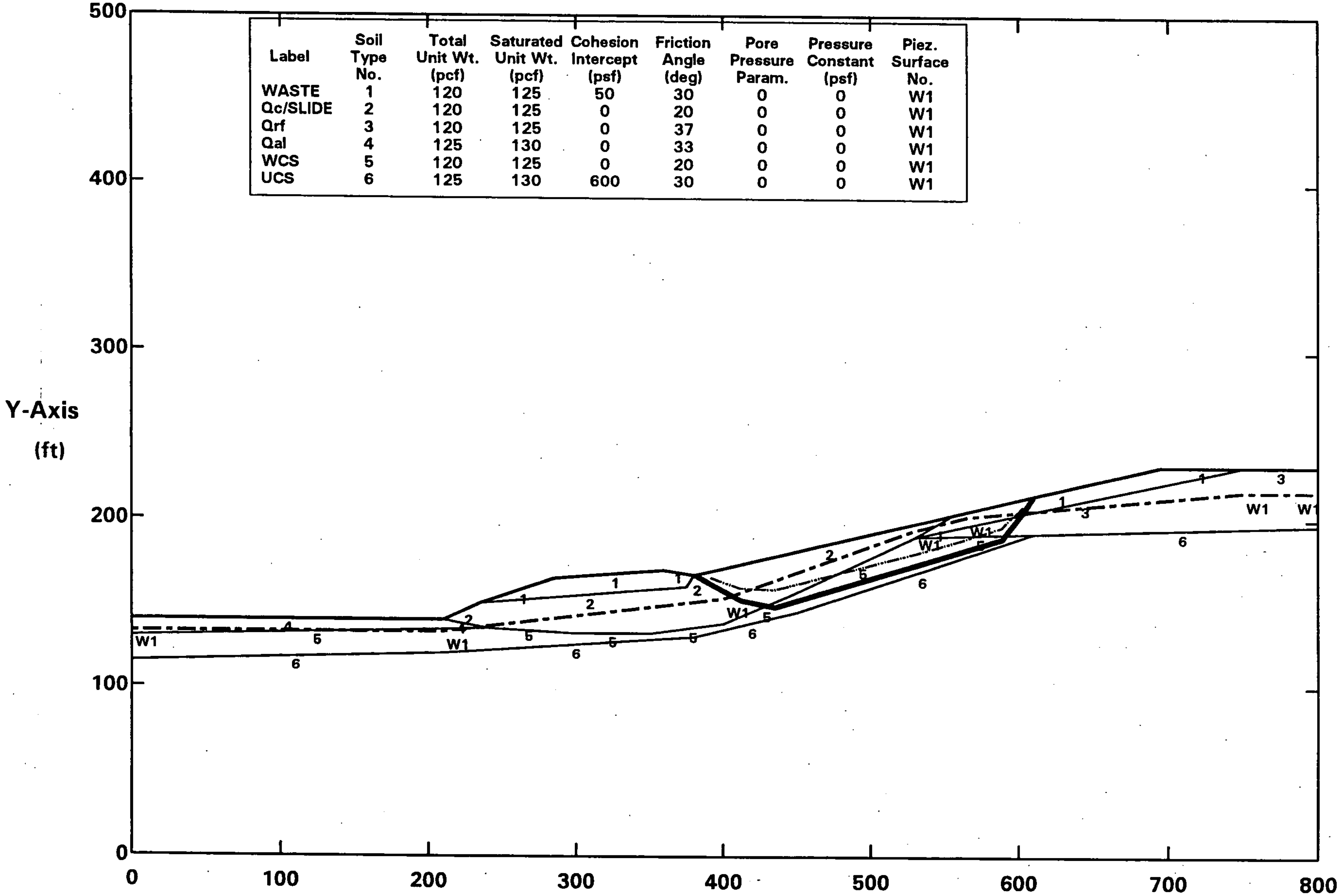
ROCKY FLATS OLF - M&E SECTION C - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:CEASS.PLT By: STAN KLINE 10-23-04 10:24pm



Factors Of Safety Calculated By The Modified Janbu Method

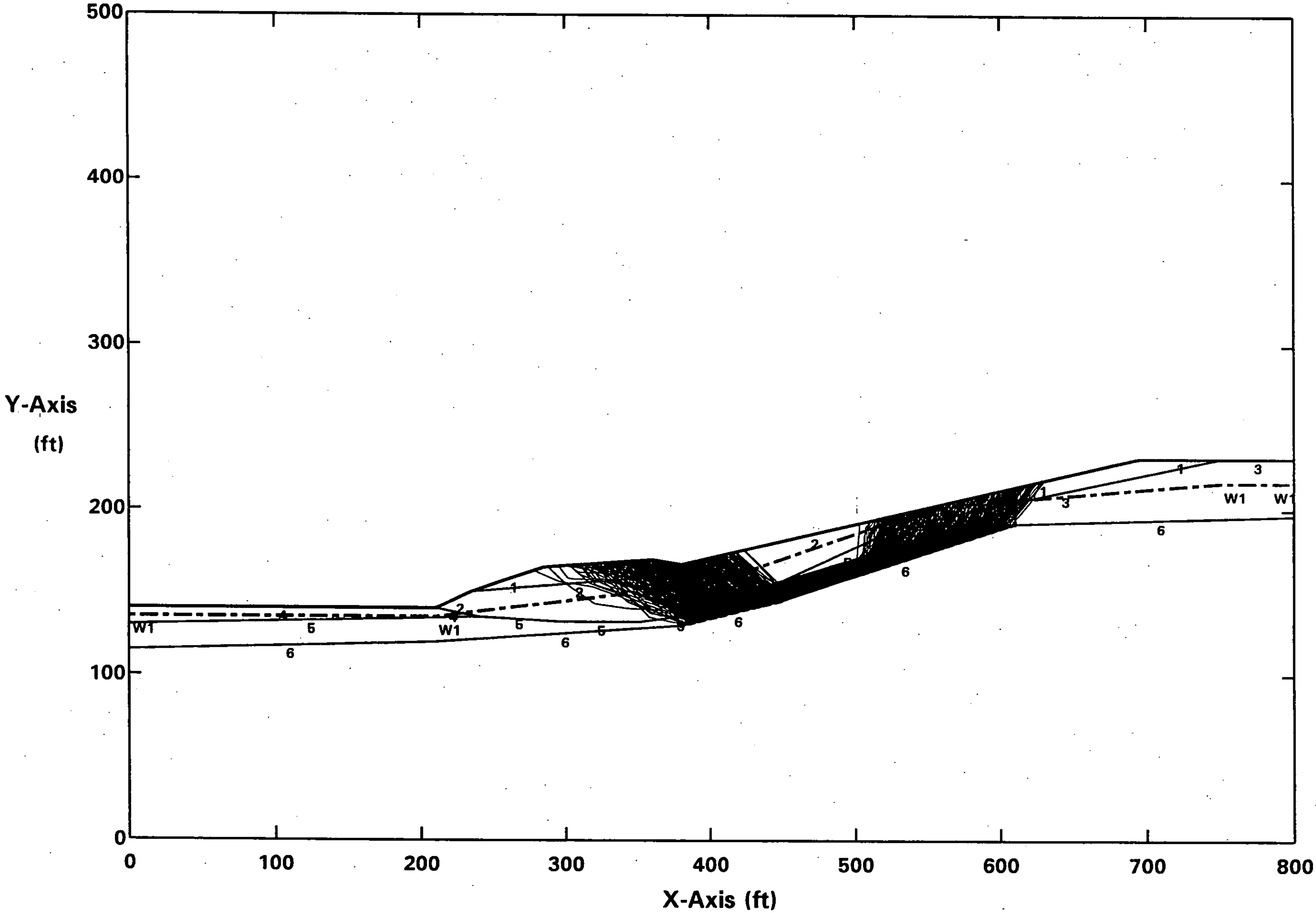
ROCKY FLATS OLF - M&E SECTION C - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-CEASS.OUT. C:CEASSSP.PLT By: STAN KLINE 10-23-04 10:25pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1



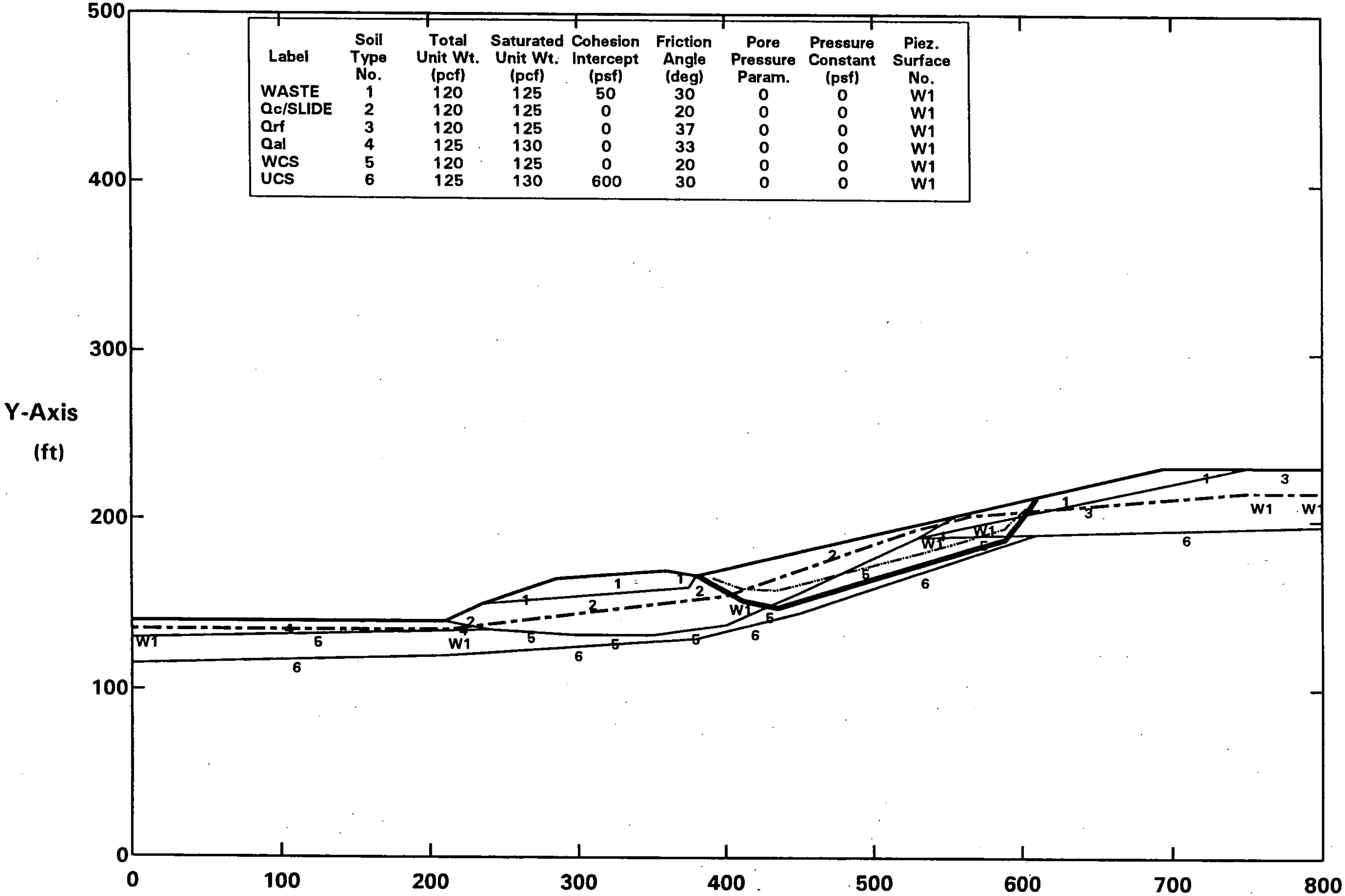
PCSTABL5M/SI FS=1.51 Theta=9.87 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E SECTION C - WCS = 20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:CEHSS.PLT By: STAN KLINE 10-23-04 7:19pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E SECTION C - WCS = 20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-CEHSS.OUT. C:CEHSSSP.PLT By: STAN KLINE 10-23-04 7:23pm

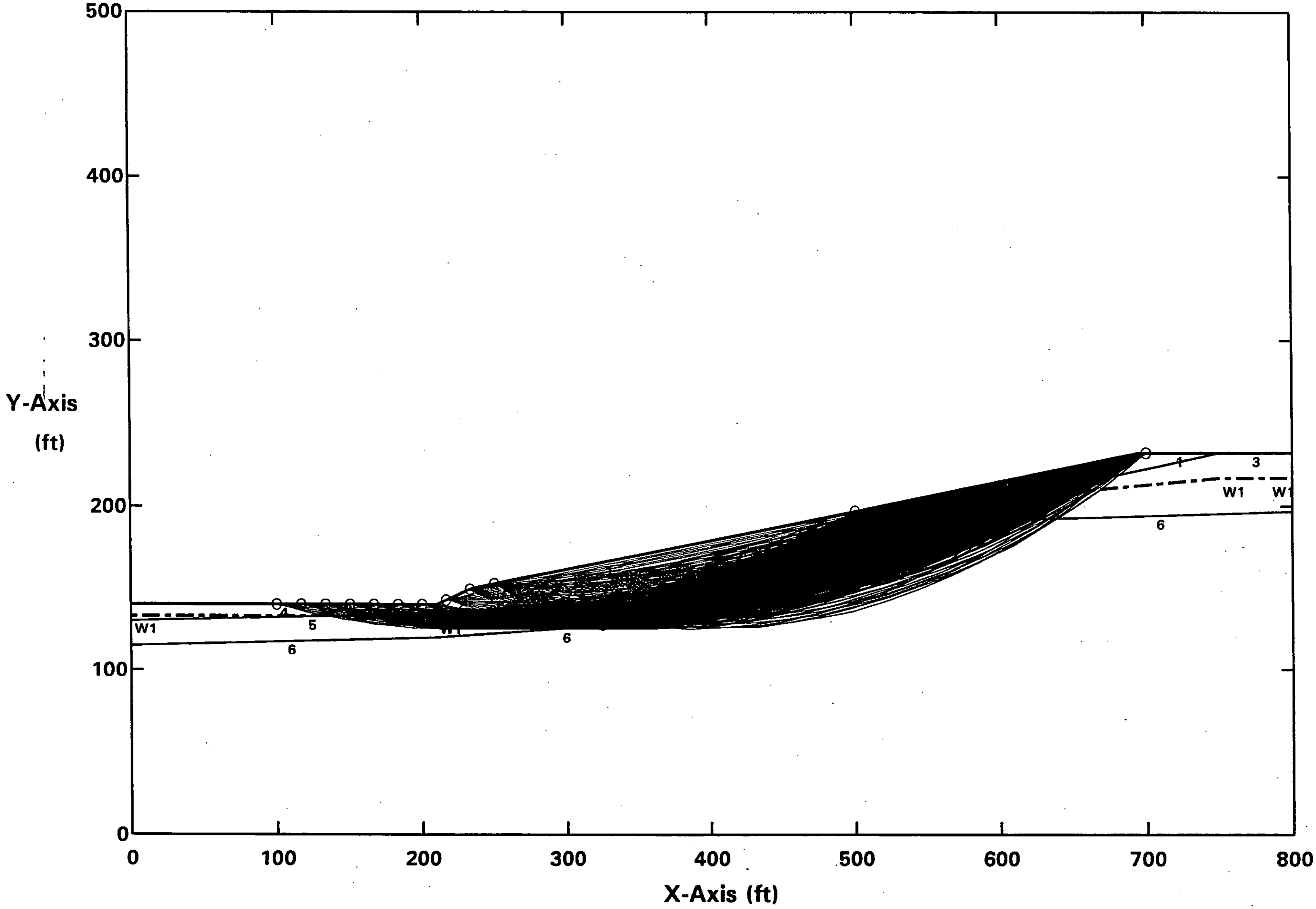


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS = 1.45 Theta = 9.88 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

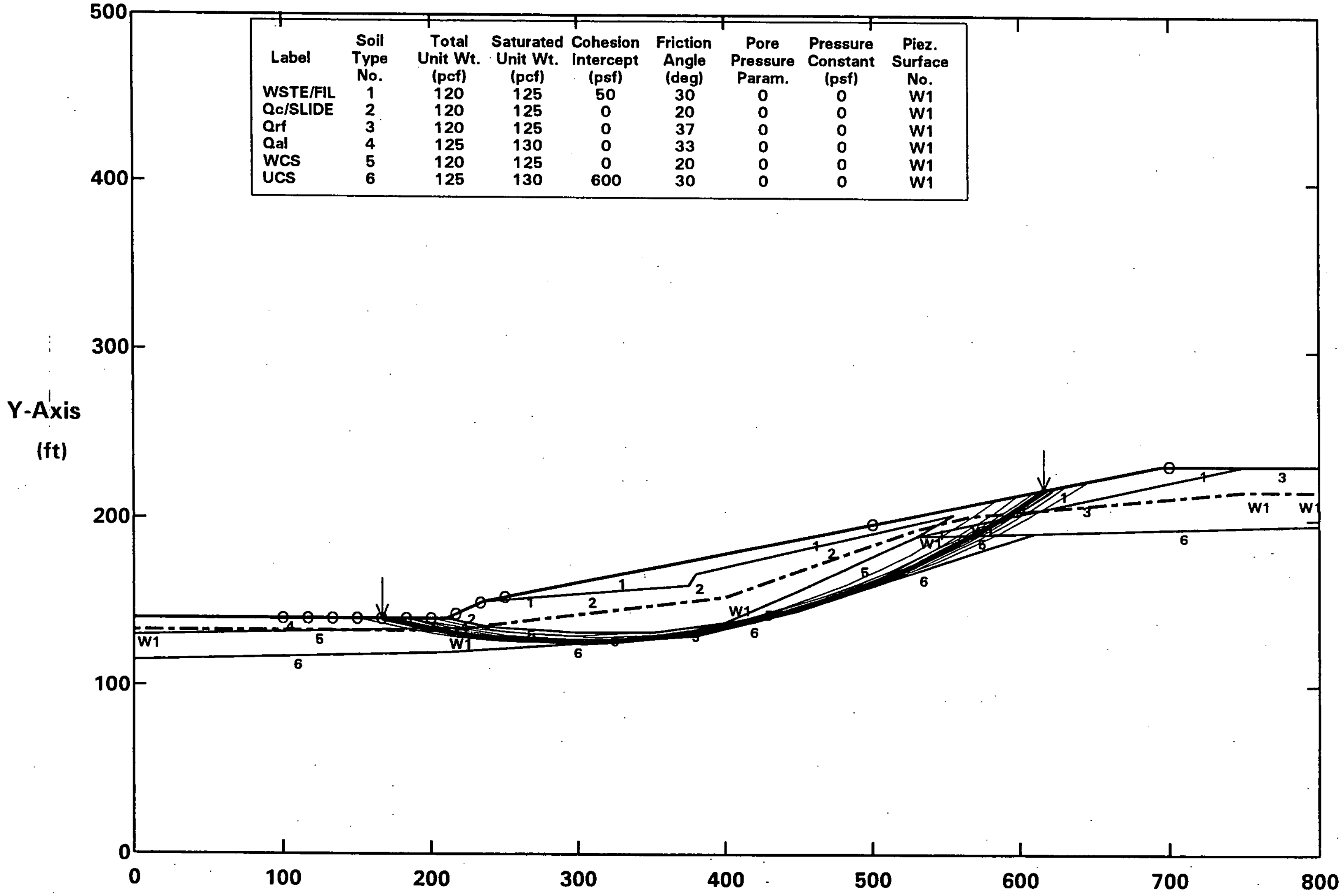
18% REGRADE CONDITION

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:CGACS.PLT By: STAN KLINE 10-23-04 10:20pm



Factors Of Safety Calculated By The Modified Bishop Method

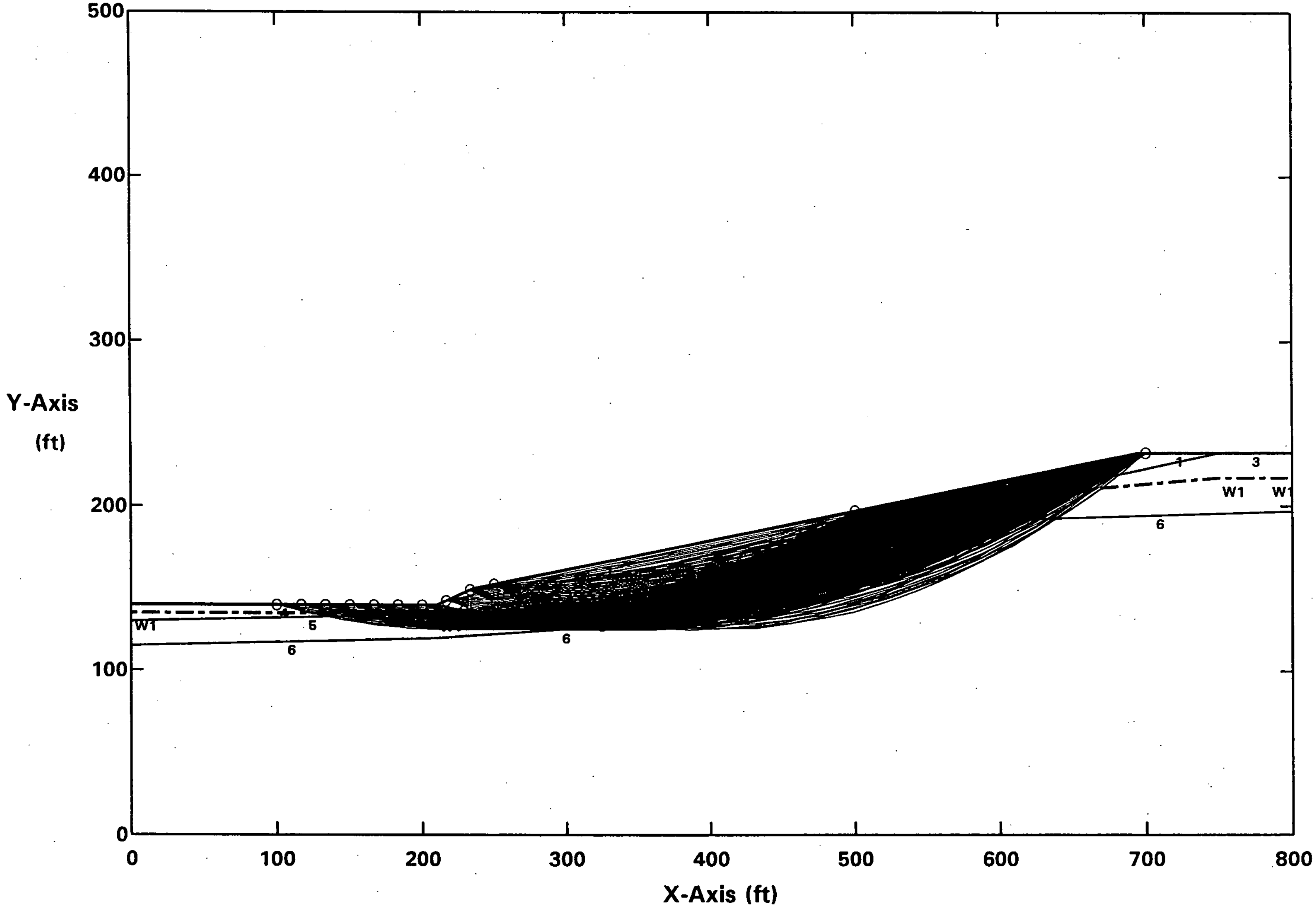
ROCKY FLATS OLF - M&E C 18% GRD - WCS=20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:CGACS.PLT By: STAN KLINE 10-23-04 10:20pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

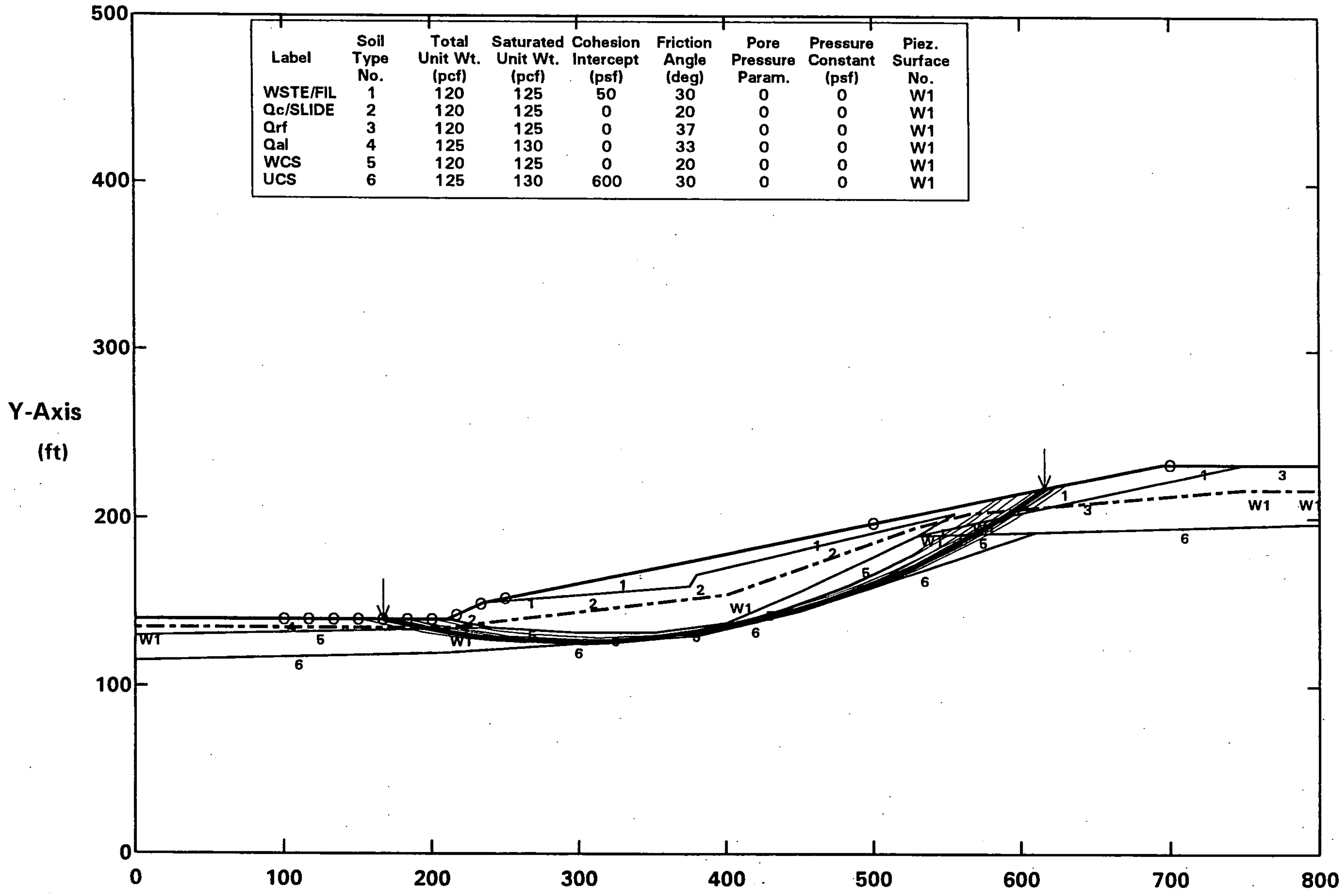
PCSTABL5M/SI FSmin=1.66 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:CGHCS.PLT By: STAN KLINE 10-23-04 9:56pm



Factors Of Safety Calculated By The Modified Bishop Method

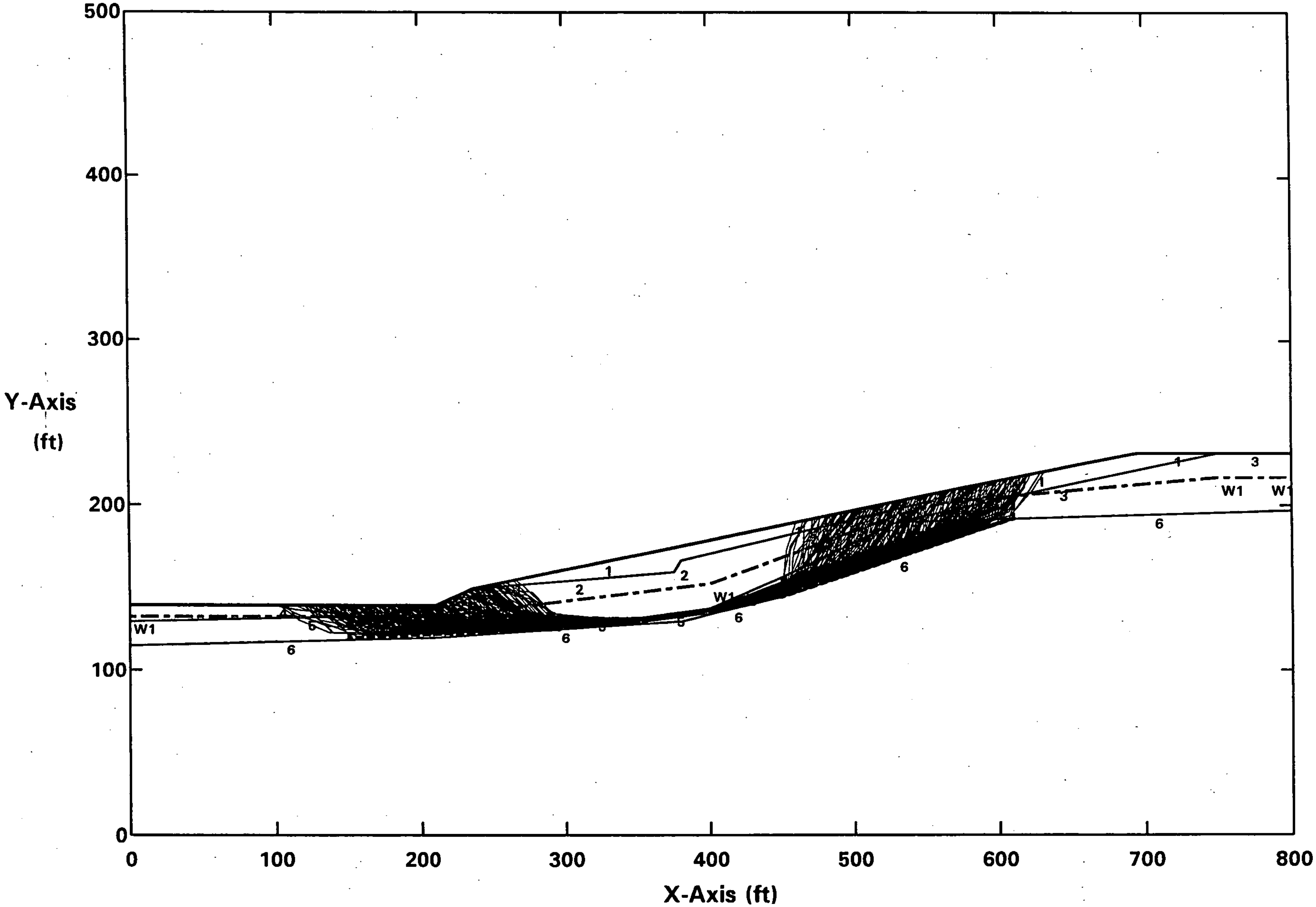
ROCKY FLATS OLF - M&E C 18% GRD - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:CGHCS.PLT By: STAN KLINE 10-23-04 9:56pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

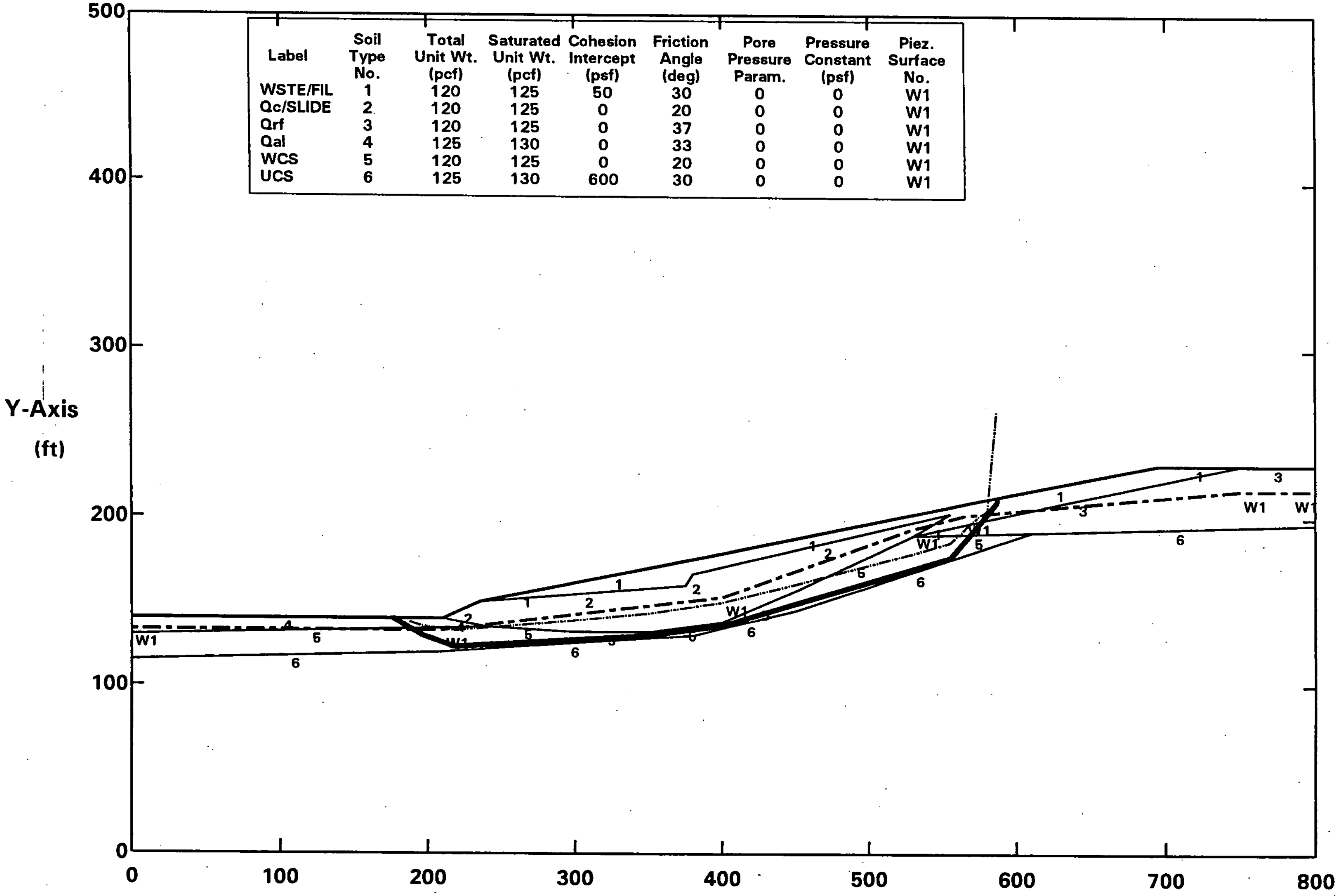
PCSTABL5M/SI FSmin = 1.61 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:CGASS.PLT By: STAN KLINE 10-23-04 10:26pm



Factors Of Safety Calculated By The Modified Janbu Method

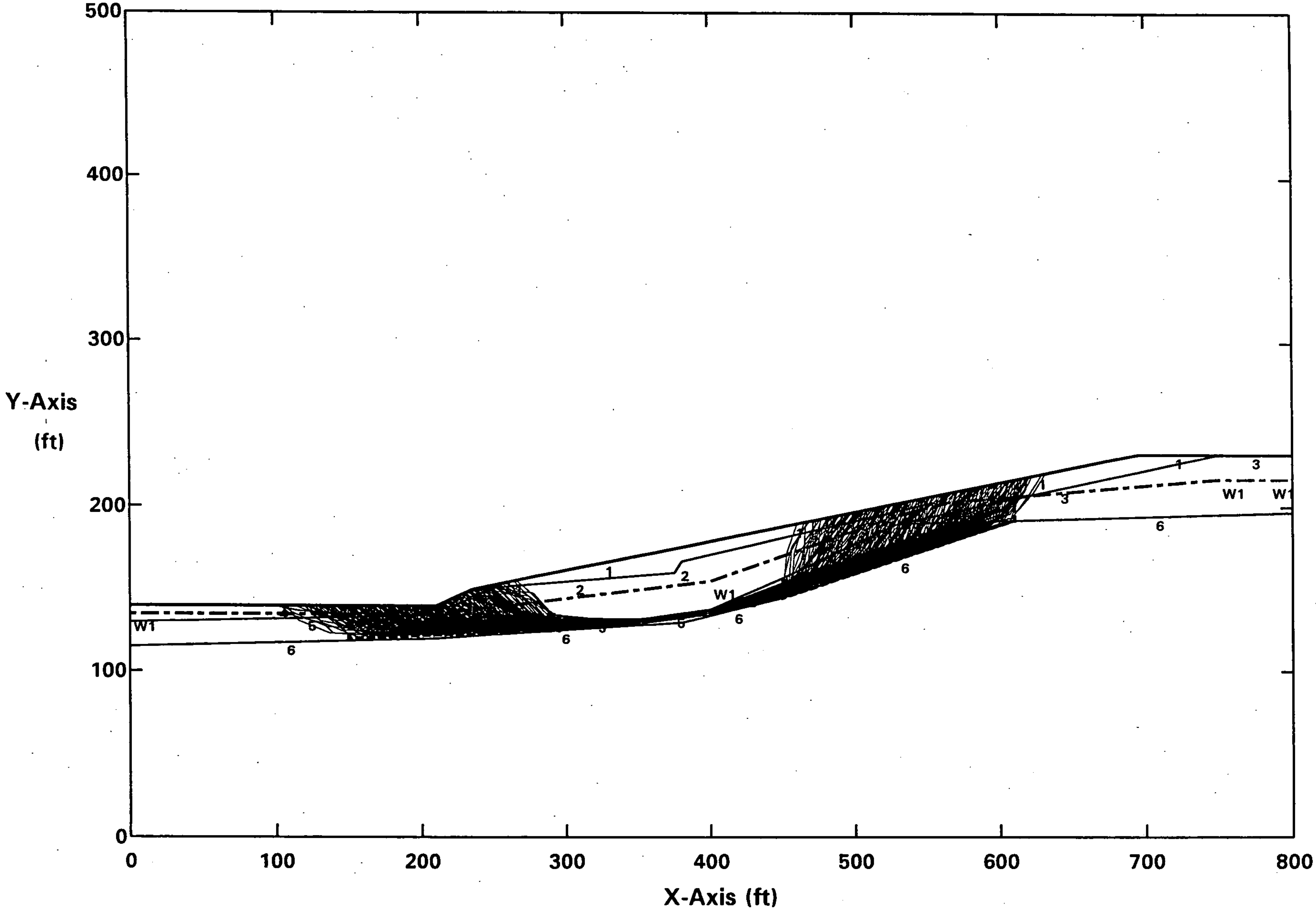
ROCKY FLATS OLF - M&E C 18% GRD - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-CGASS.OUT. C:CGASSSP.PLT By: STAN KLINE 10-23-04 10:29pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS=1.65 Theta=9.43 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

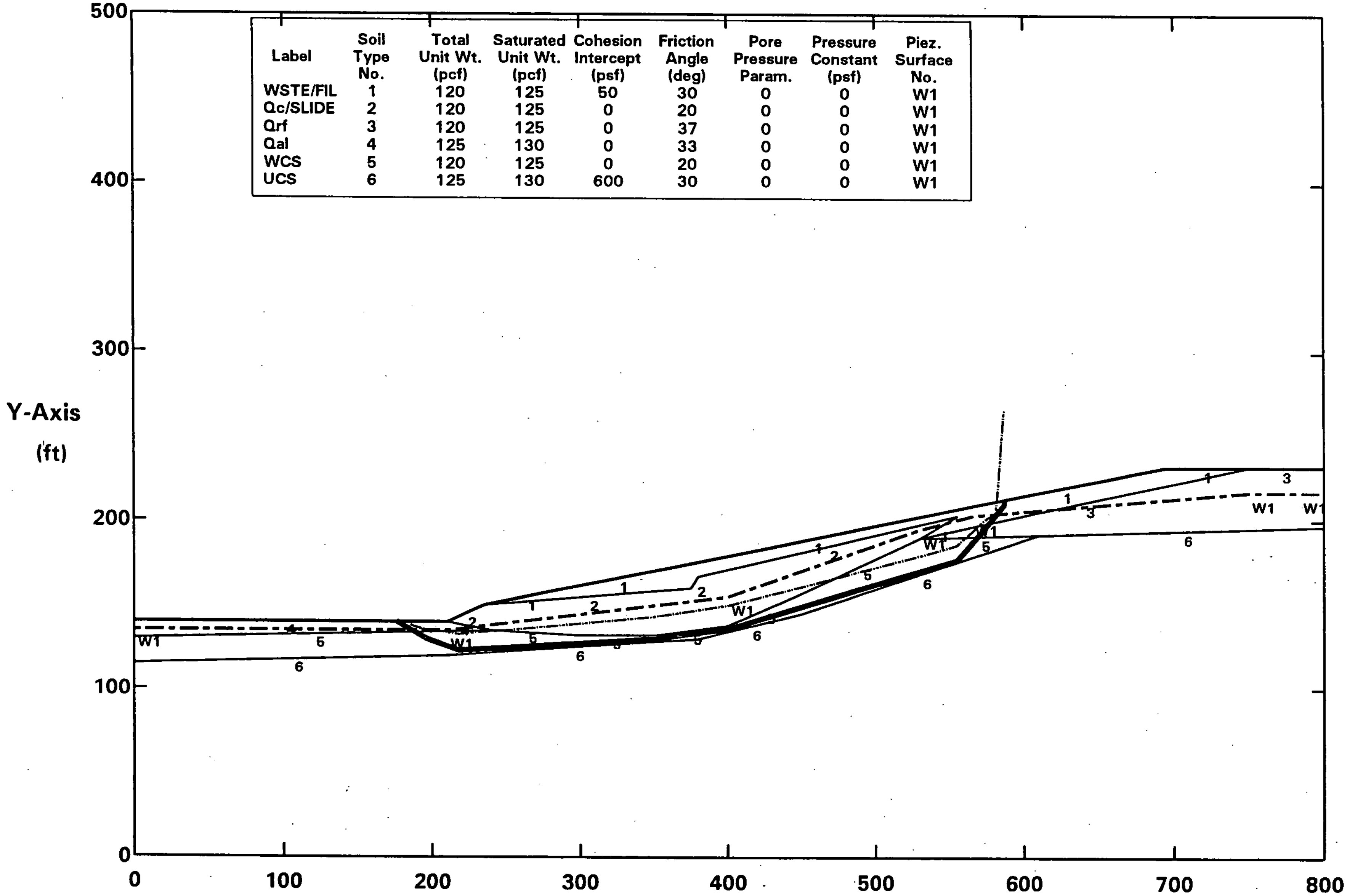
ROCKY FLATS OLF - M&E C 18% GRD - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:CGHSS.PLT By: STAN KLINE 10-23-04 7:42pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-CGHSS.OUT. C:CGHSSSP.PLT By: STAN KLINE 10-23-04 8:02pm

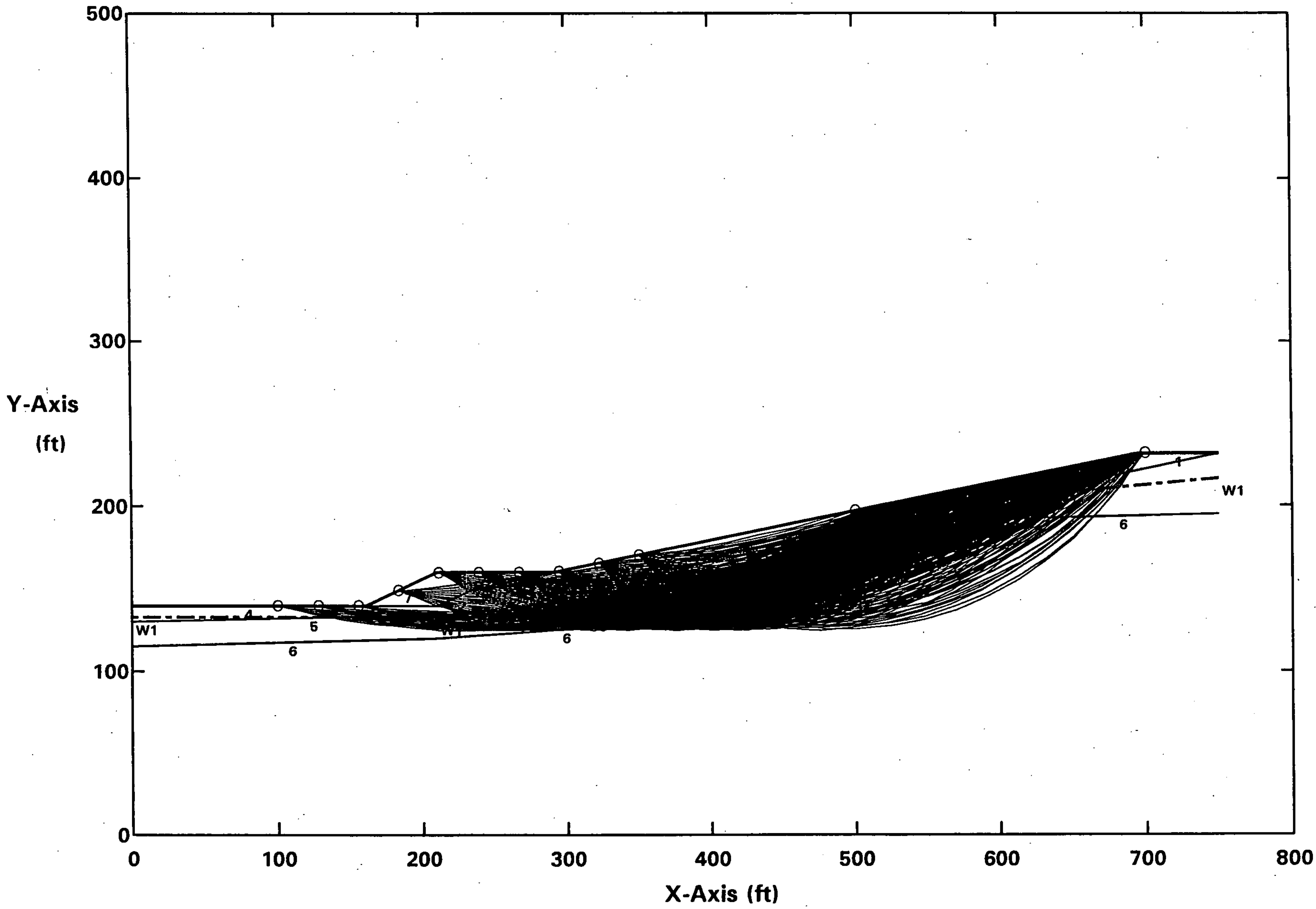
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS = 1.59 Theta = 9.46 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

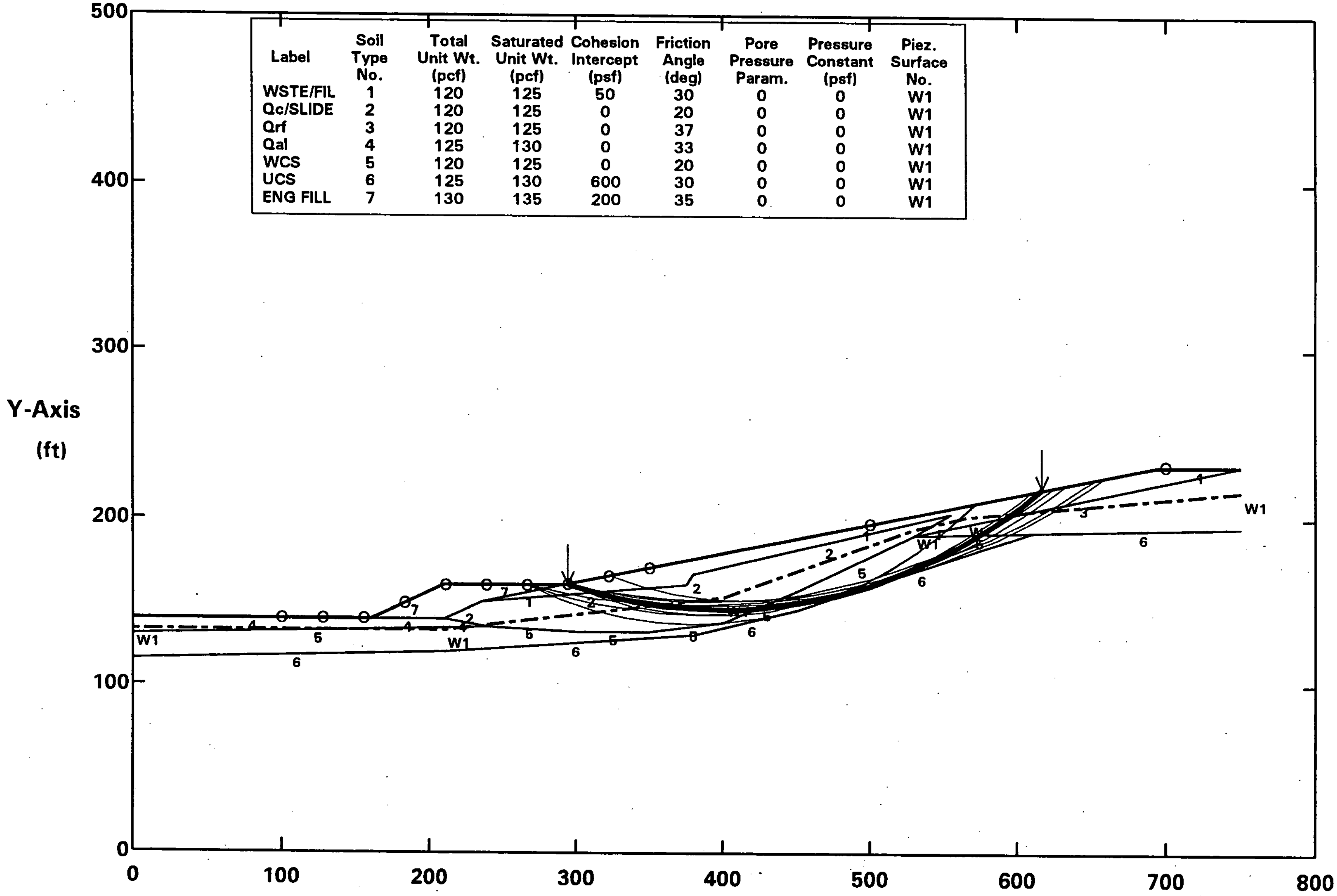
18% REGRADE WITH BUTTRESS CONDITION

ROCKY FLATS OLF - M&E C 18%W/BM - WCS=20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:CBACS.PLT By: STAN KLINE 10-23-04 10:22pm



Factors Of Safety Calculated By The Modified Bishop Method

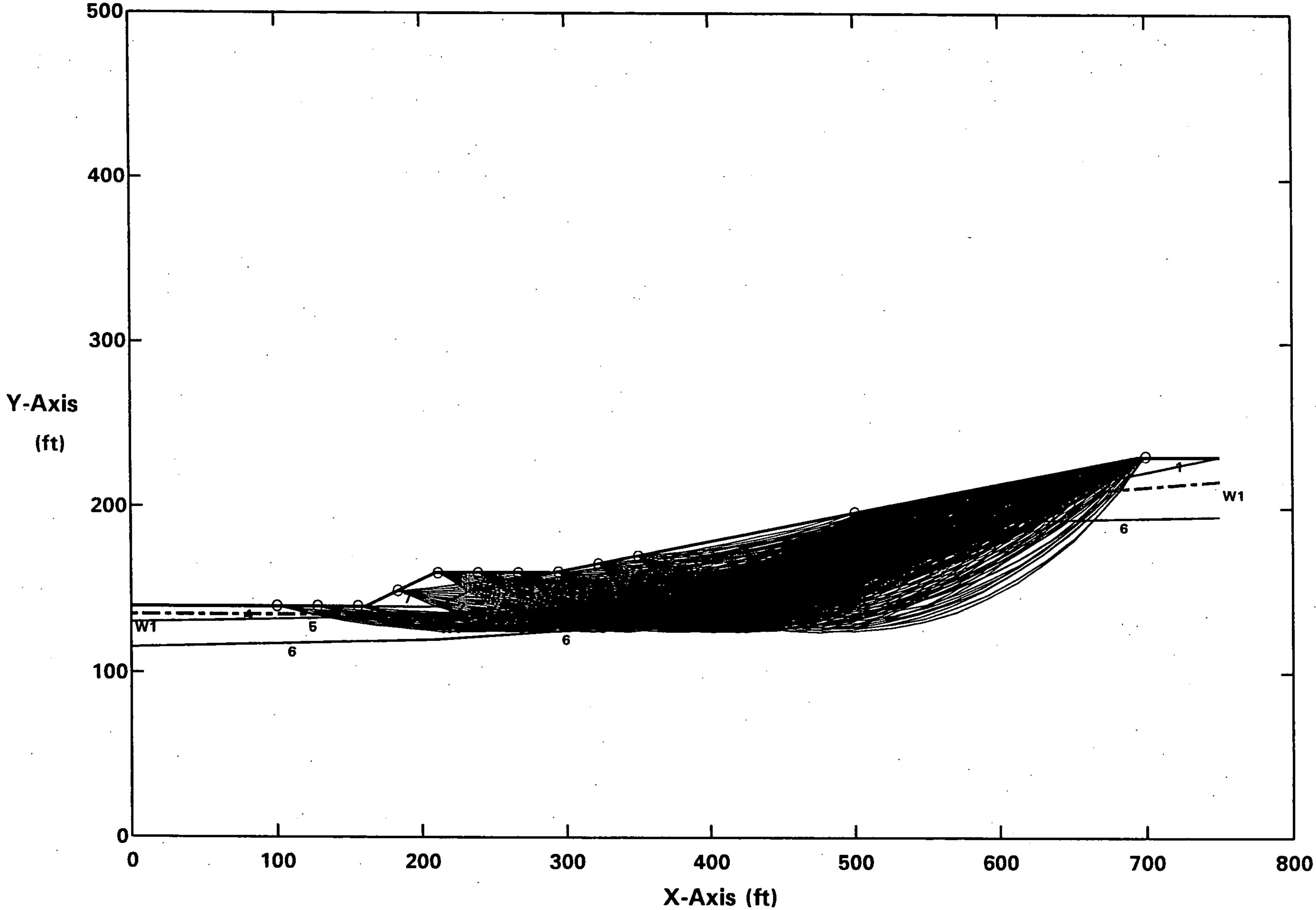
ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:CBACS.PLT By: STAN KLINE 10-23-04 10:22pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

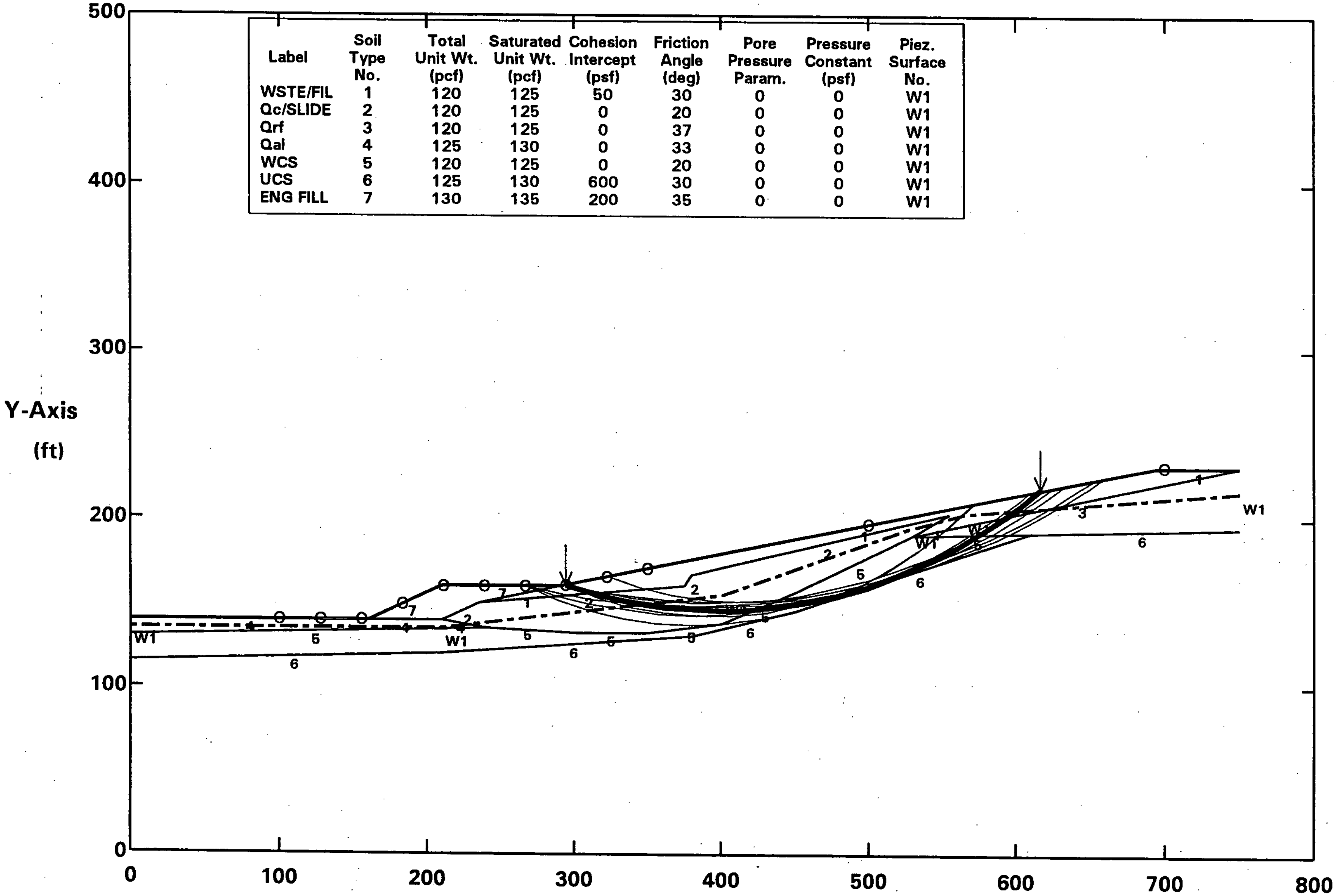
PCSTABL5M/SI FSmin = 1.83 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:CBHCS.PLT By: STAN KLINE 10-23-04 10:03pm



Factors Of Safety Calculated By The Modified Bishop Method

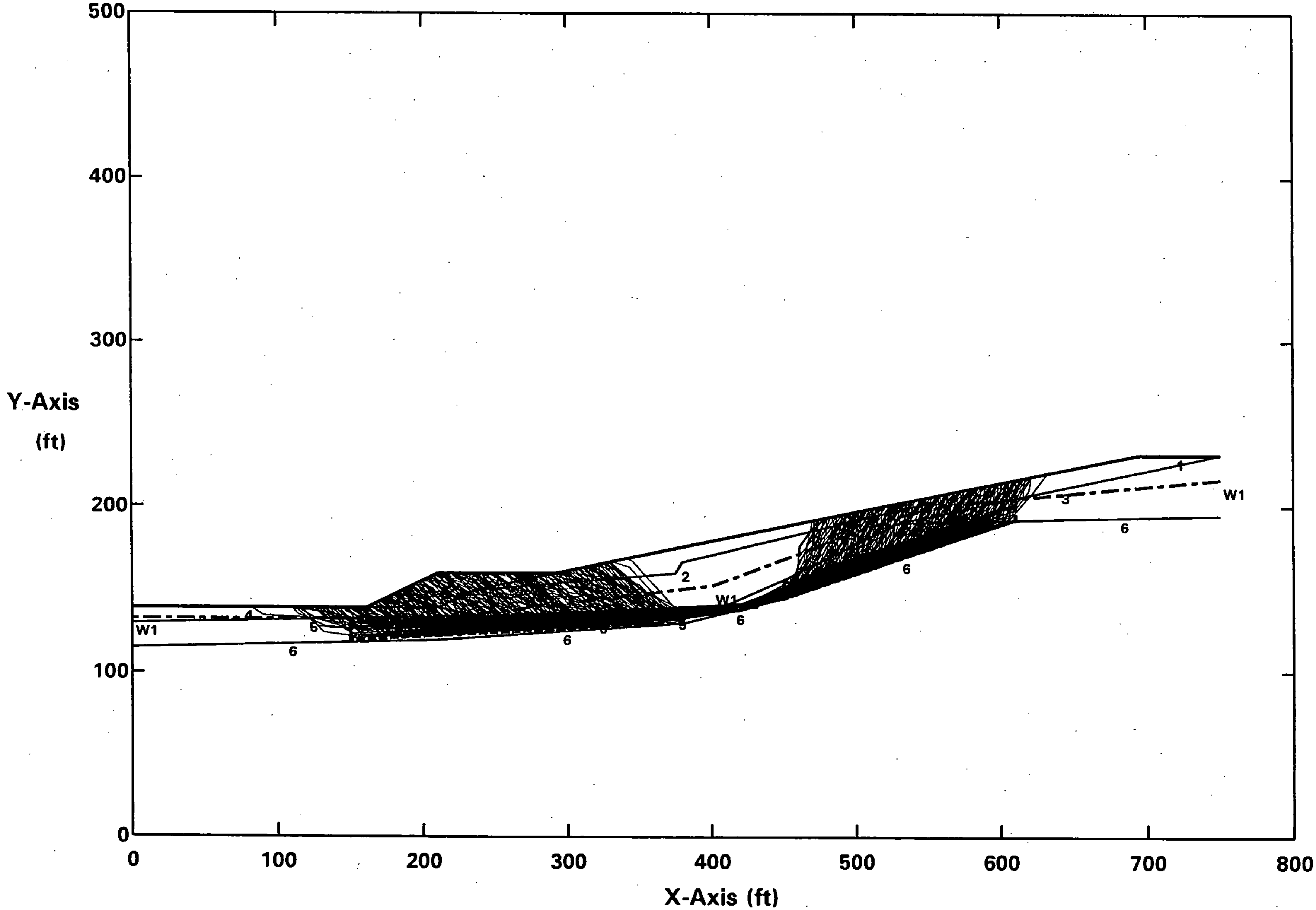
ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:CBHCS.PLT By: STAN KLINE 10-23-04 10:03pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

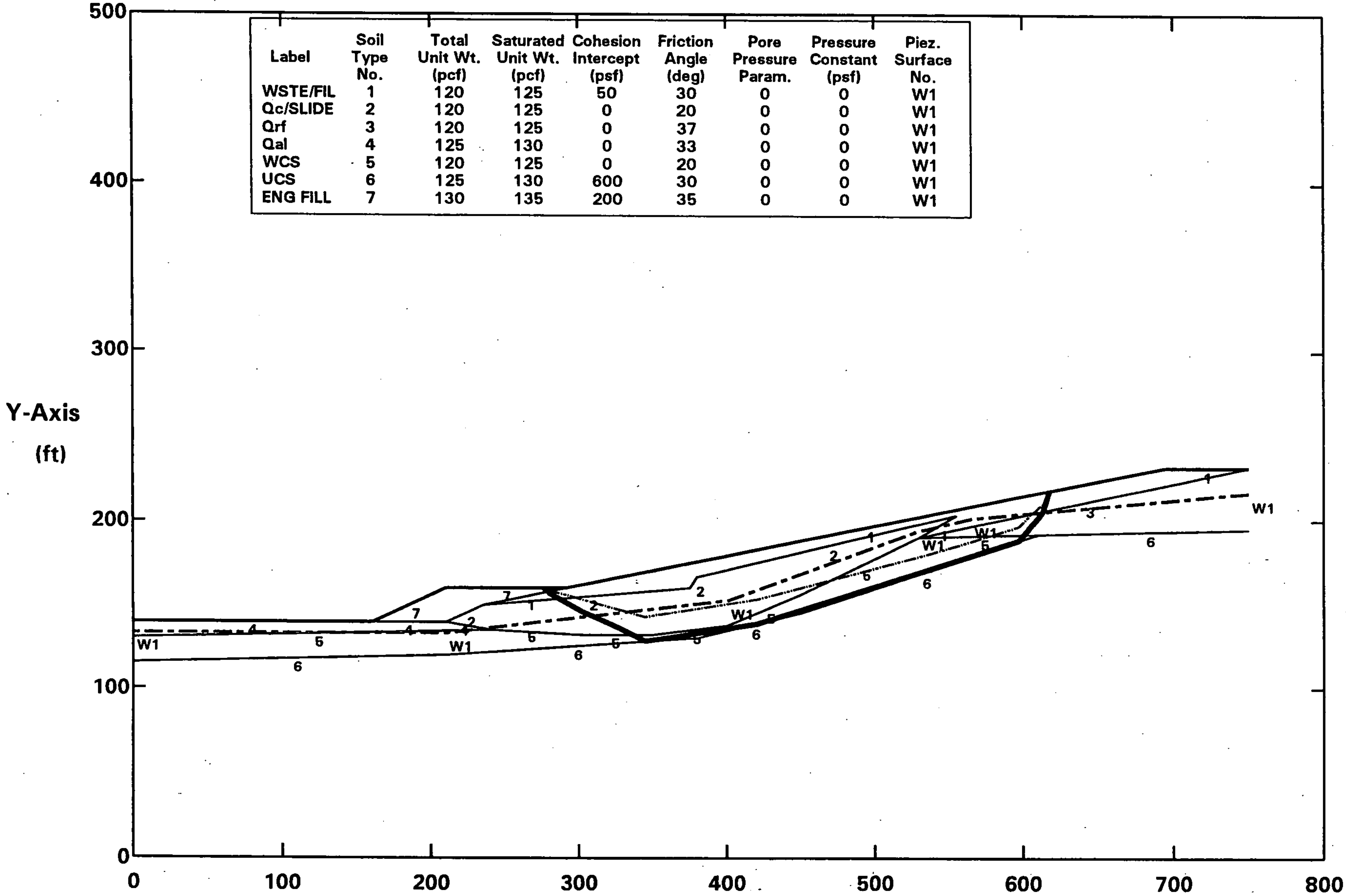
PCSTABL5M/SI FSmin = 1.78 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 20 deg - W/AVEGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:CBASS.PLT By: STAN KLINE 10-23-04 10:31pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E C 18%W/BM - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-CBASS.OUT. C:CBASSSP.PLT By: STAN KLINE 10-23-04 10:33pm

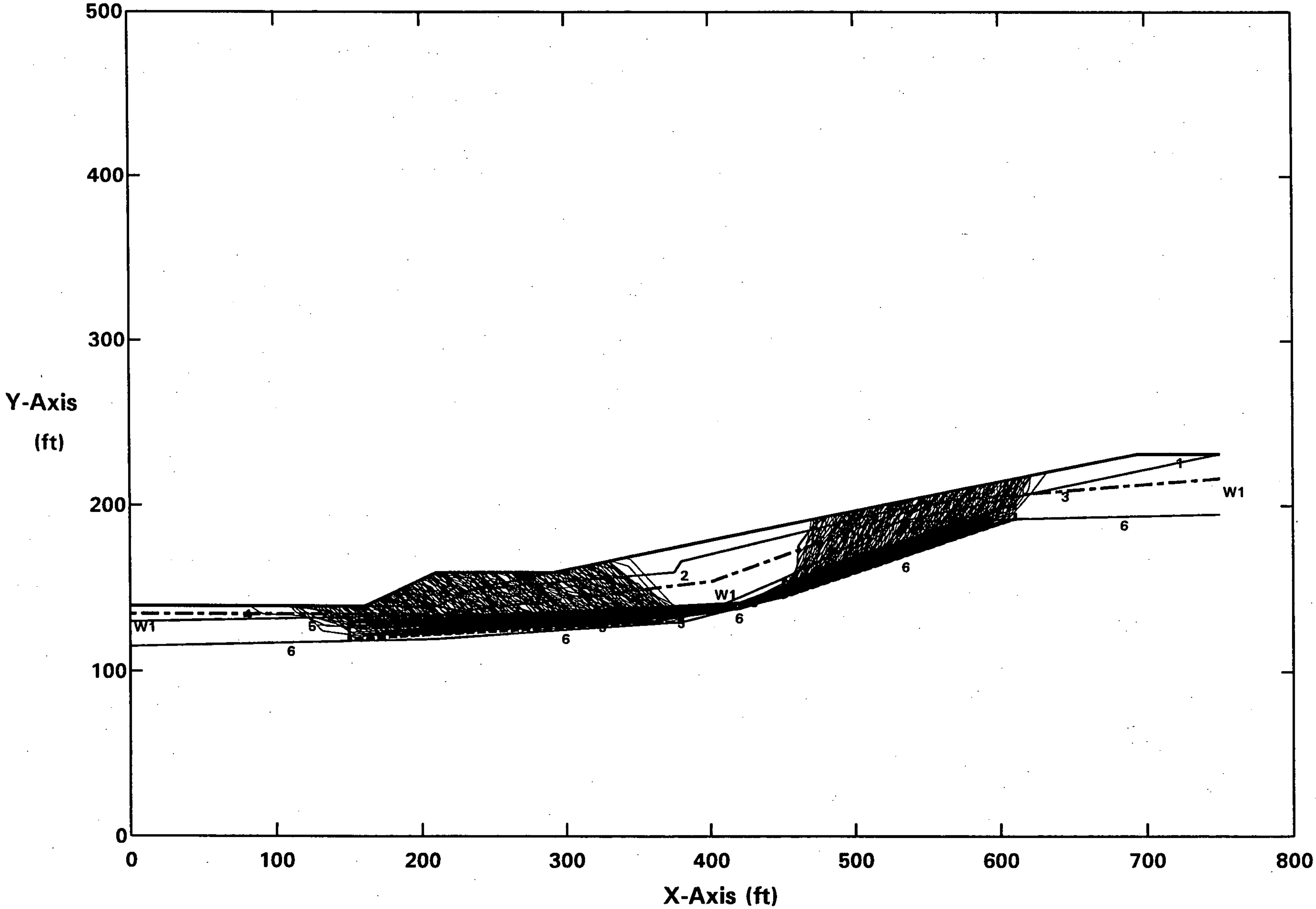


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FS=1.87 Theta=8.57 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

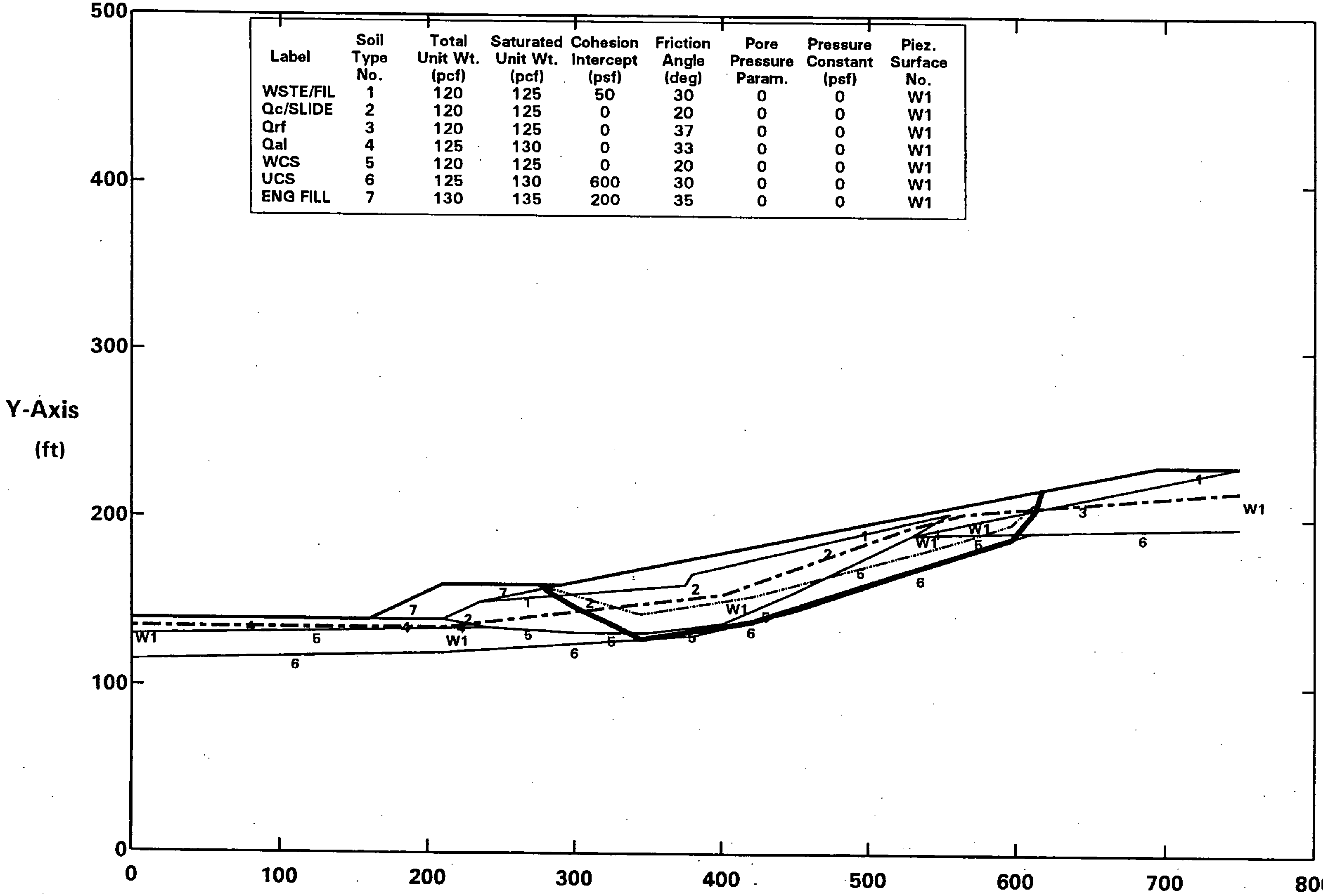
ROCKY FLATS OLF - M&E C 18%W/BM - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC

All surfaces evaluated. C:CBHSS.PLT By: STAN KLINE 10-23-04 9:01pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E C 18%W/BM - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-CBHSS.OUT. C:CBHSSSP.PLT By: STAN KLINE 10-23-04 9:03pm



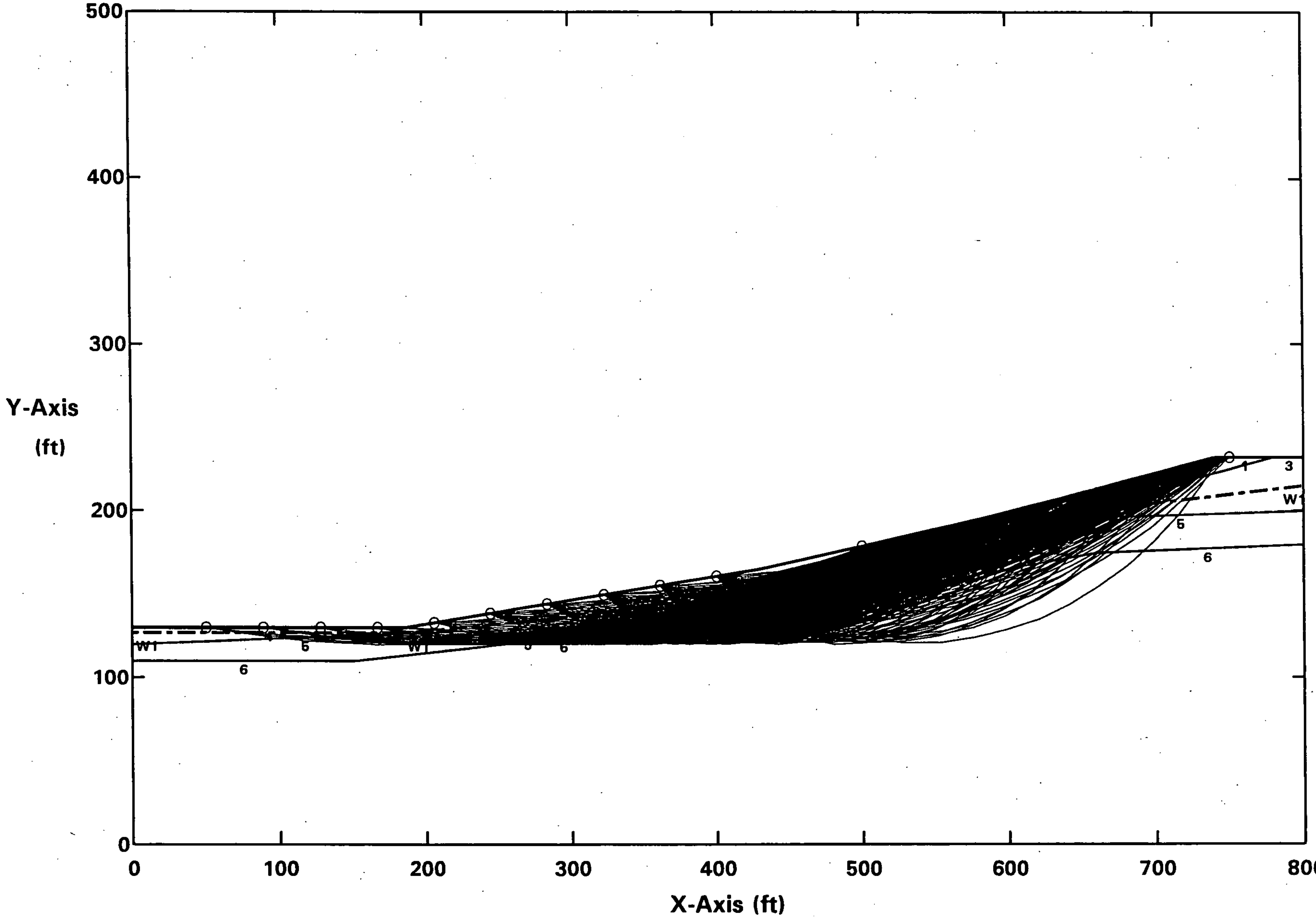
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FS=1.82 Theta=8.55 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

M&E SECTION D-D' – STATIC

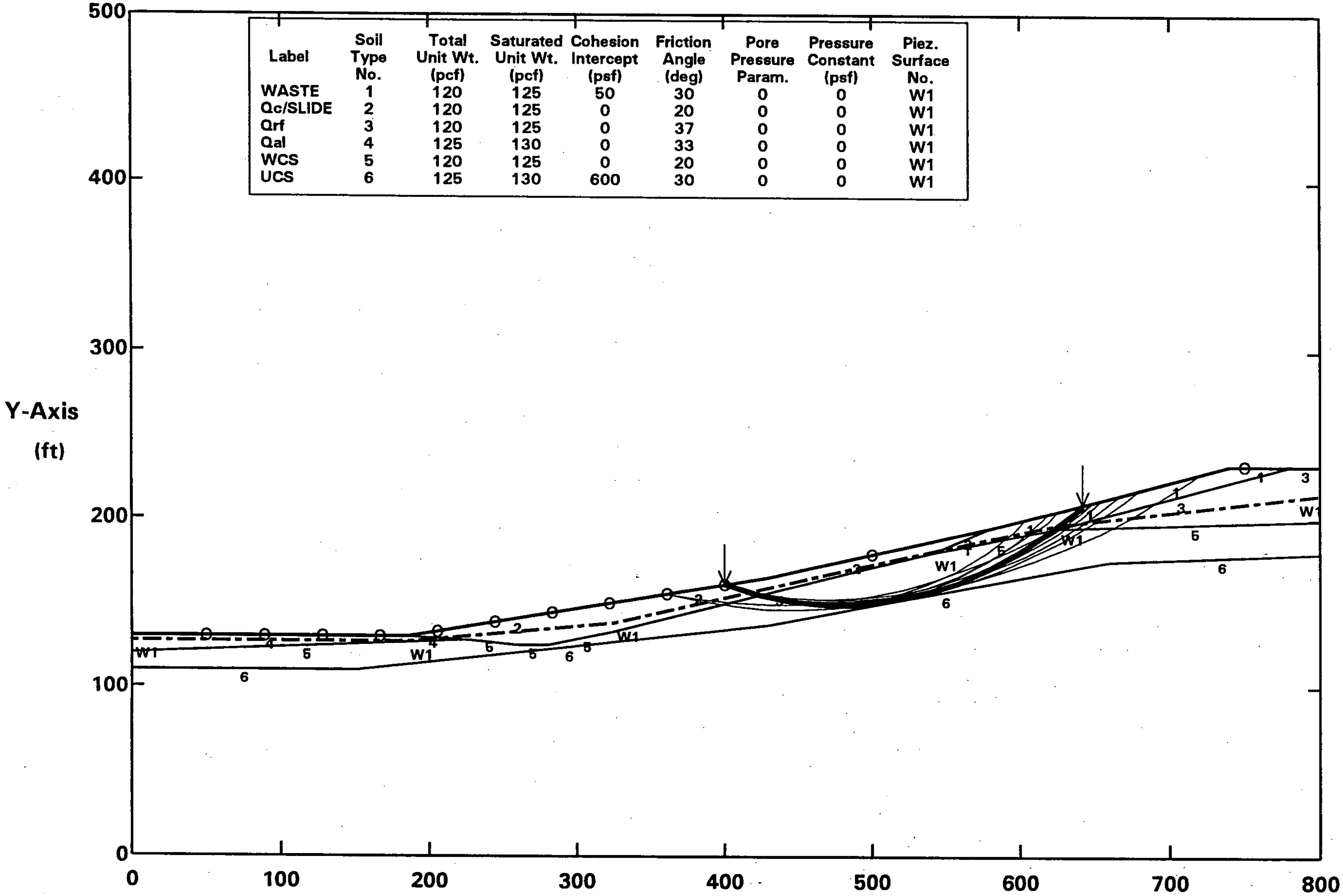
EXISTING CONDITIONS

ROCKY FLATS OLF - M&E SECTION D - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:DEACS.PLT By: STAN KLINE 10-24-04 2:08am



Factors Of Safety Calculated By The Modified Bishop Method

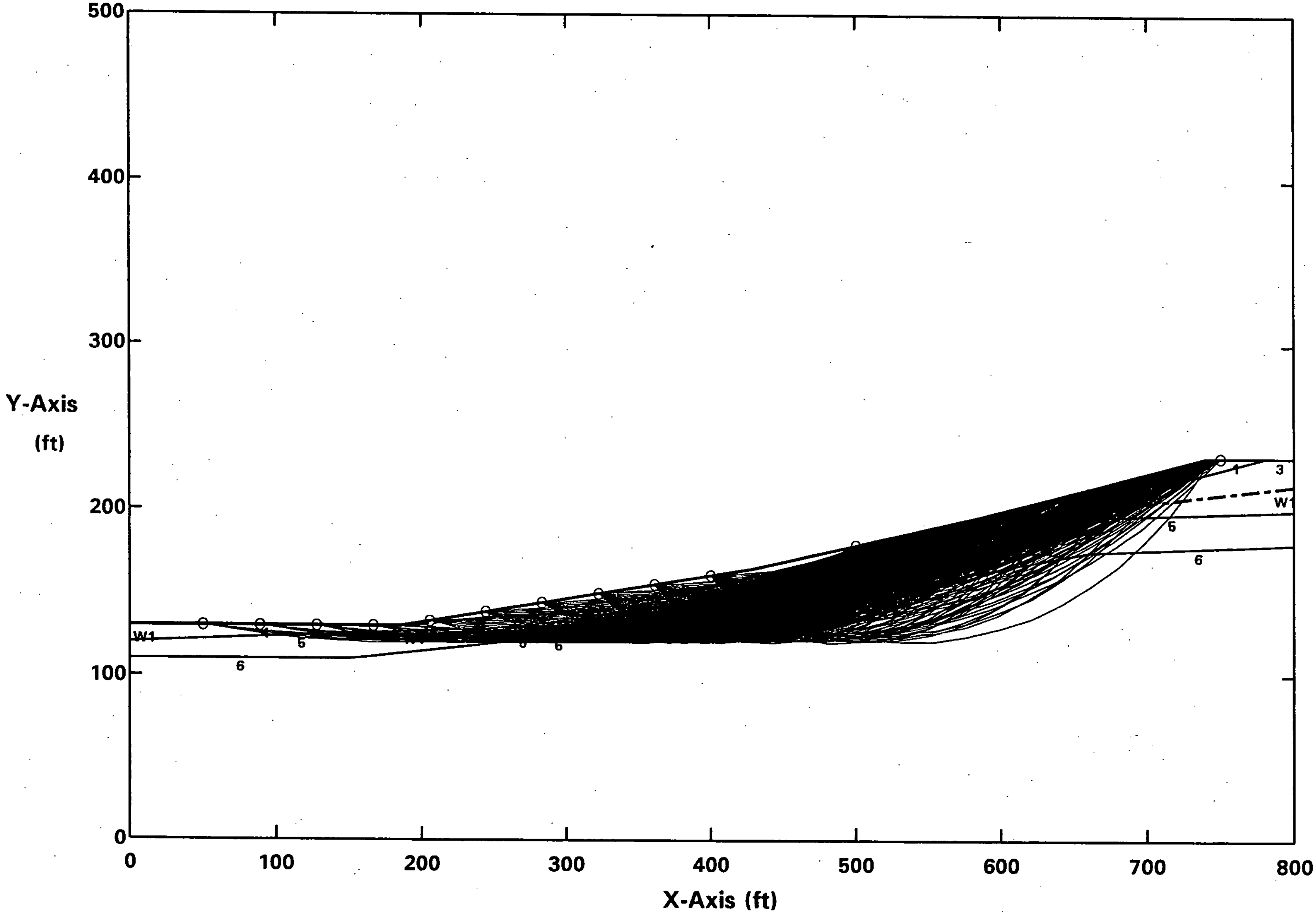
ROCKY FLATS OLF - M&E SECTION D - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:DEACS.PLT By: STAN KLINE 10-24-04 2:08am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

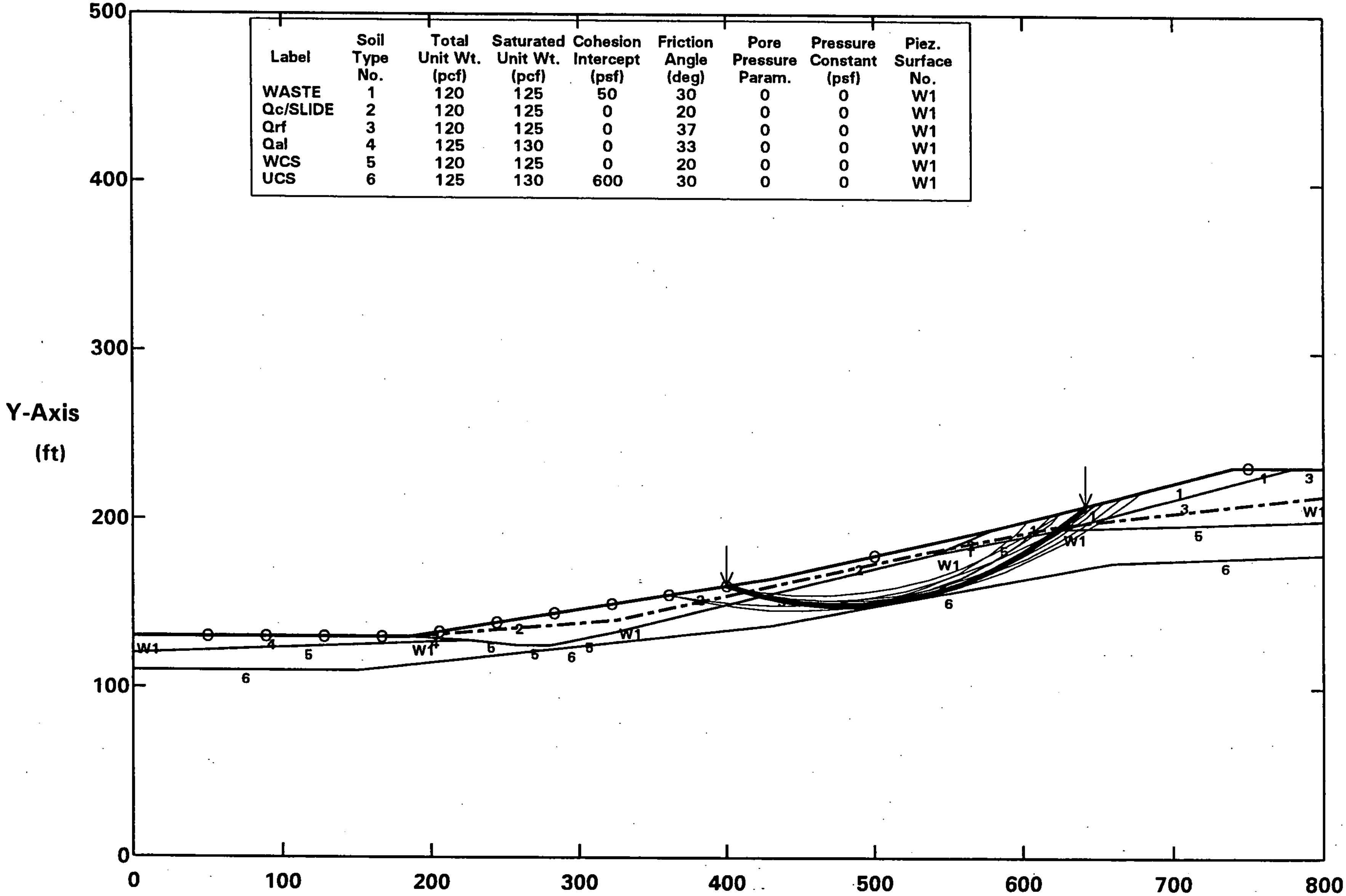
PCSTABL5M/SI FSmin = 1.31 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION D - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:DEHCS.PLT By: STAN KLINE 10-24-04 12:58am



Factors Of Safety Calculated By The Modified Bishop Method

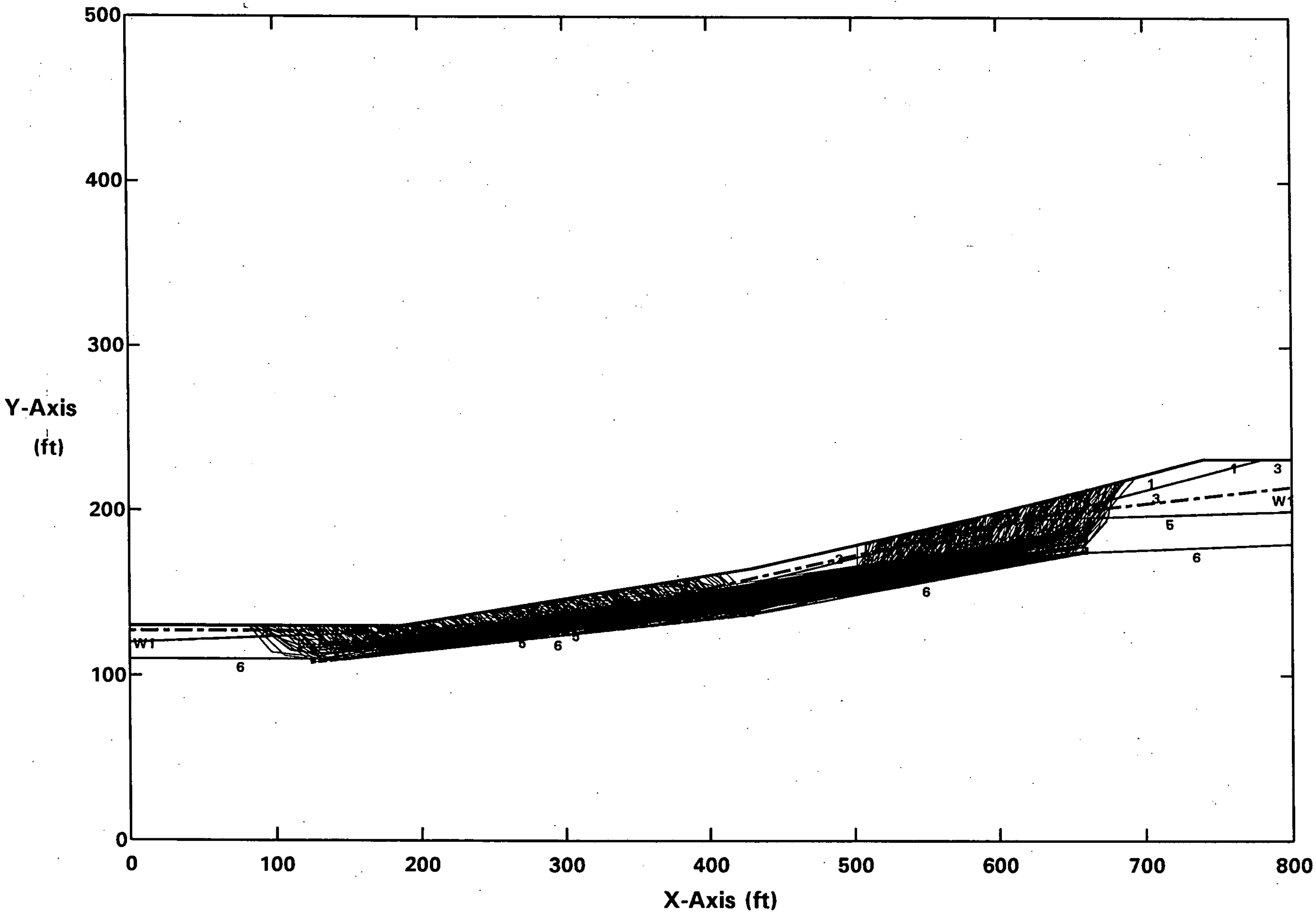
ROCKY FLATS OLF - M&E SECTION D - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:DEHCS.PLT By: STAN KLINE 10-24-04 12:58am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

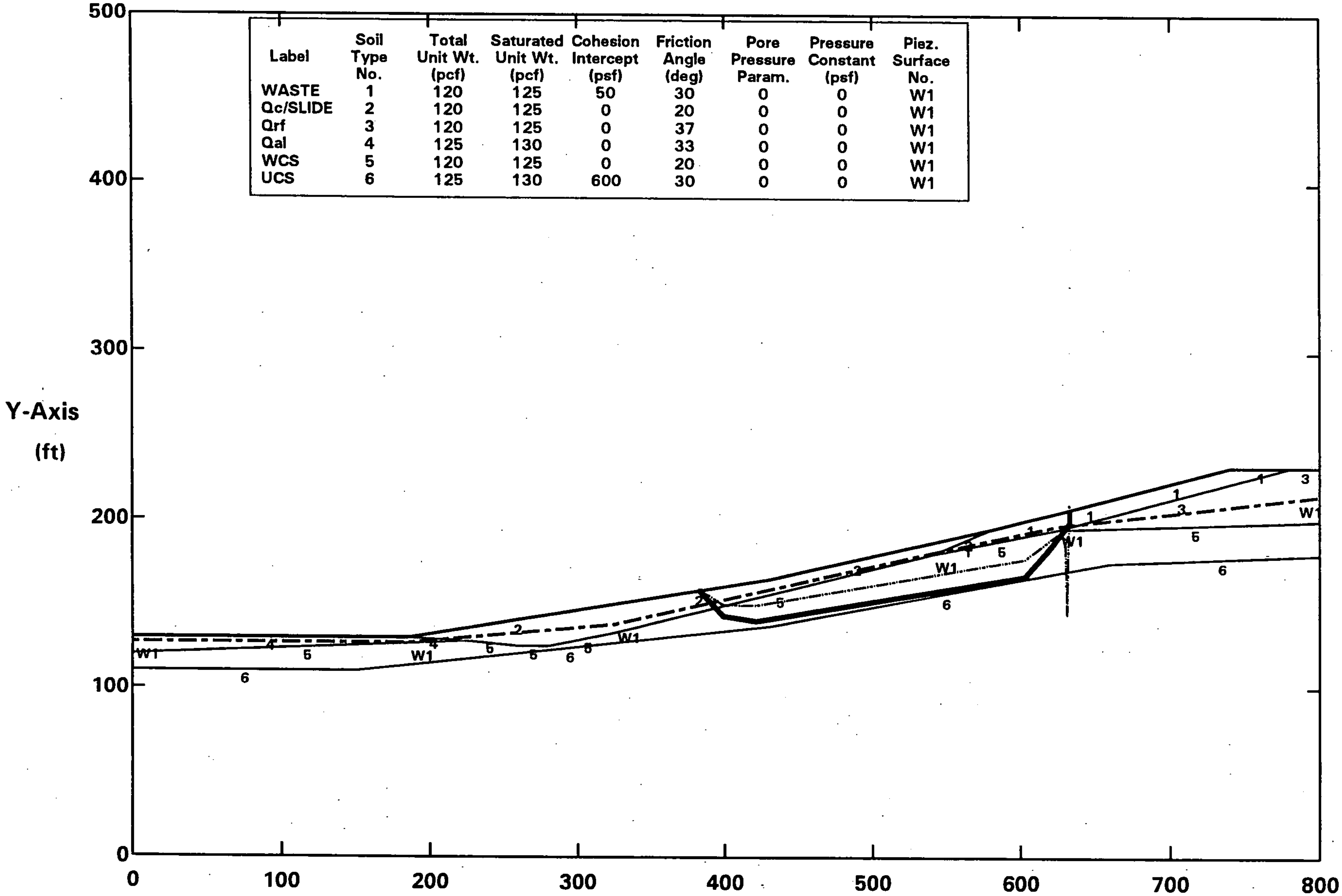
PCSTABL5M/SI FSmin = 1.26 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION D - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:DEASS.PLT By: STAN KLINE 10-24-04 2:22am



Factors Of Safety Calculated By The Modified Janbu Method

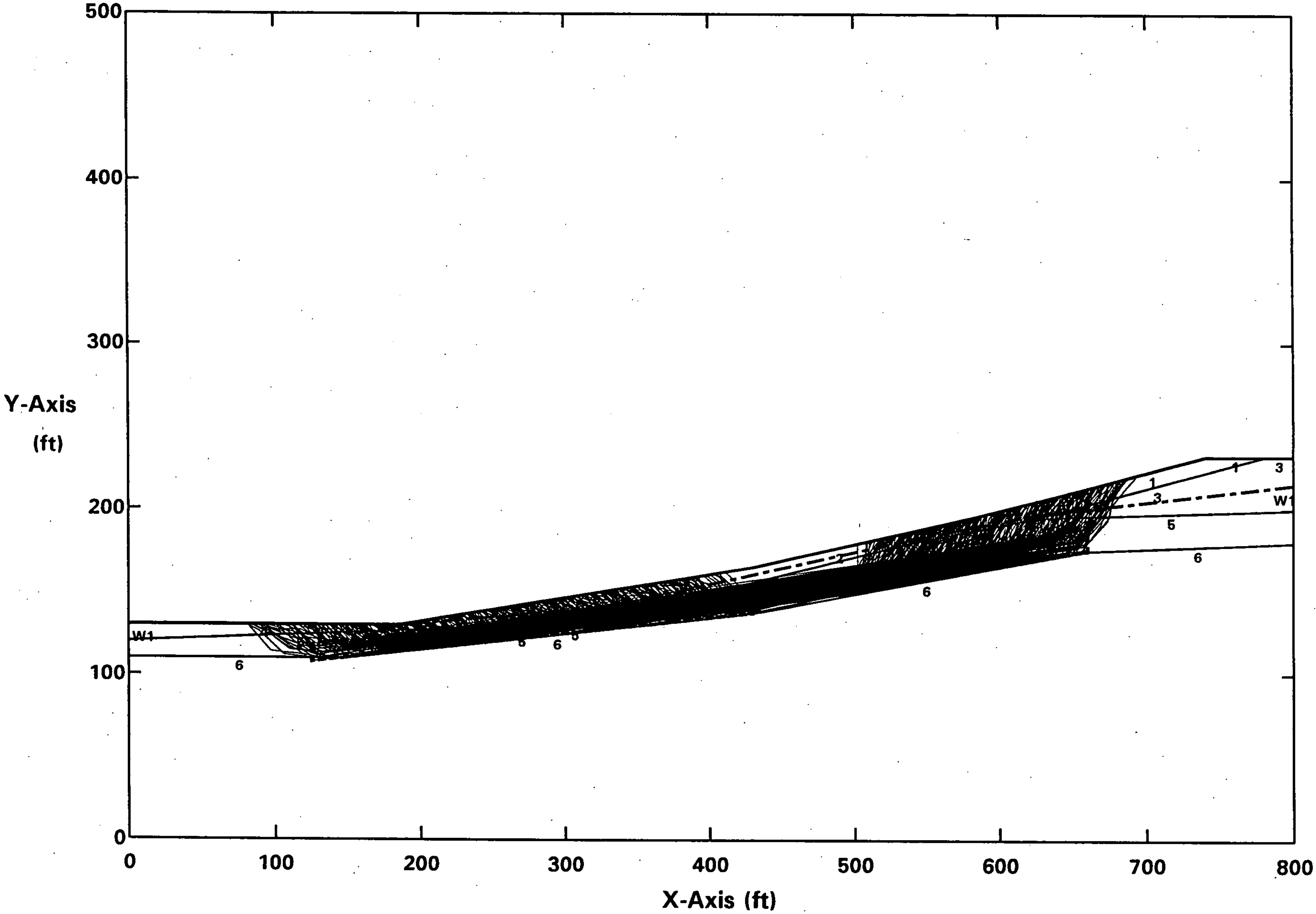
ROCKY FLATS OLF - M&E SECTION D - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-DEASS.OUT. C:DEASSSP.PLT By: STAN KLINE 10-24-04 2:22am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

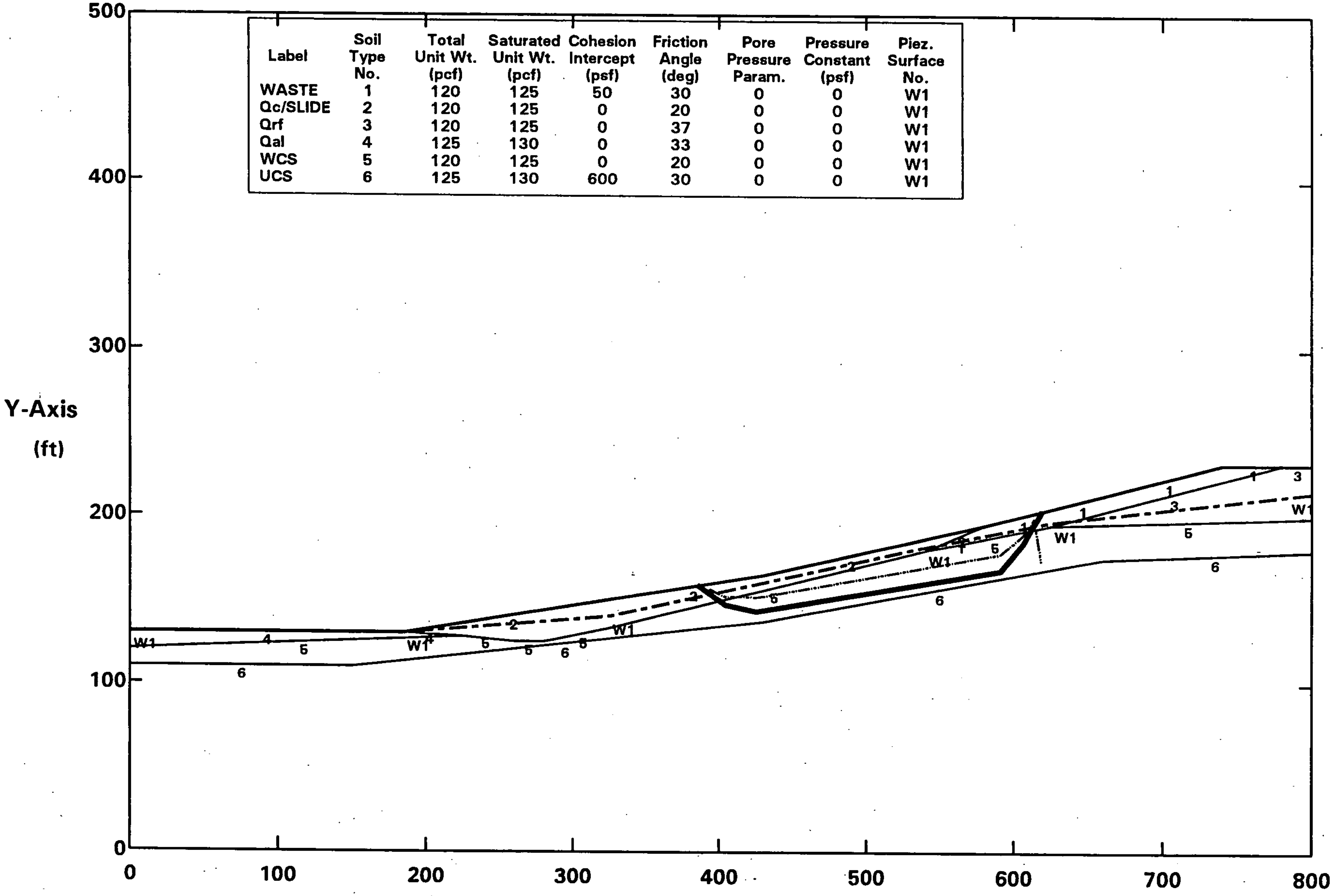
PCSTABL5M/SI FS=1.45 Theta=8.89 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E SECTION D - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:DEHSS.PLT By: STAN KLINE 10-23-04 10:50pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E SECTION D - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-DEHSS.OUT. C:DEHSSSP.PLT By: STAN KLINE 10-23-04 11:23pm

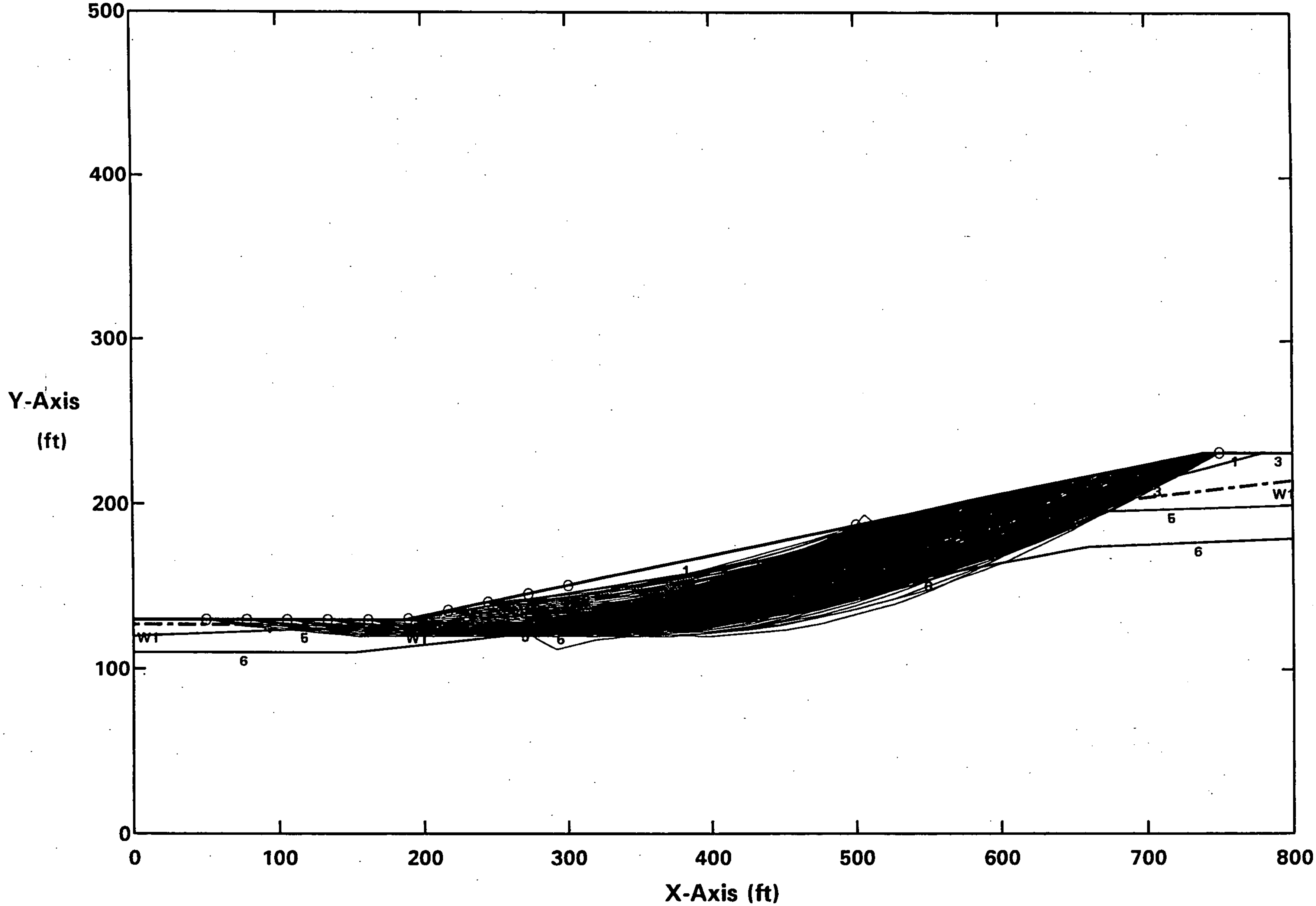


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS=1.39 Theta=9.31 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

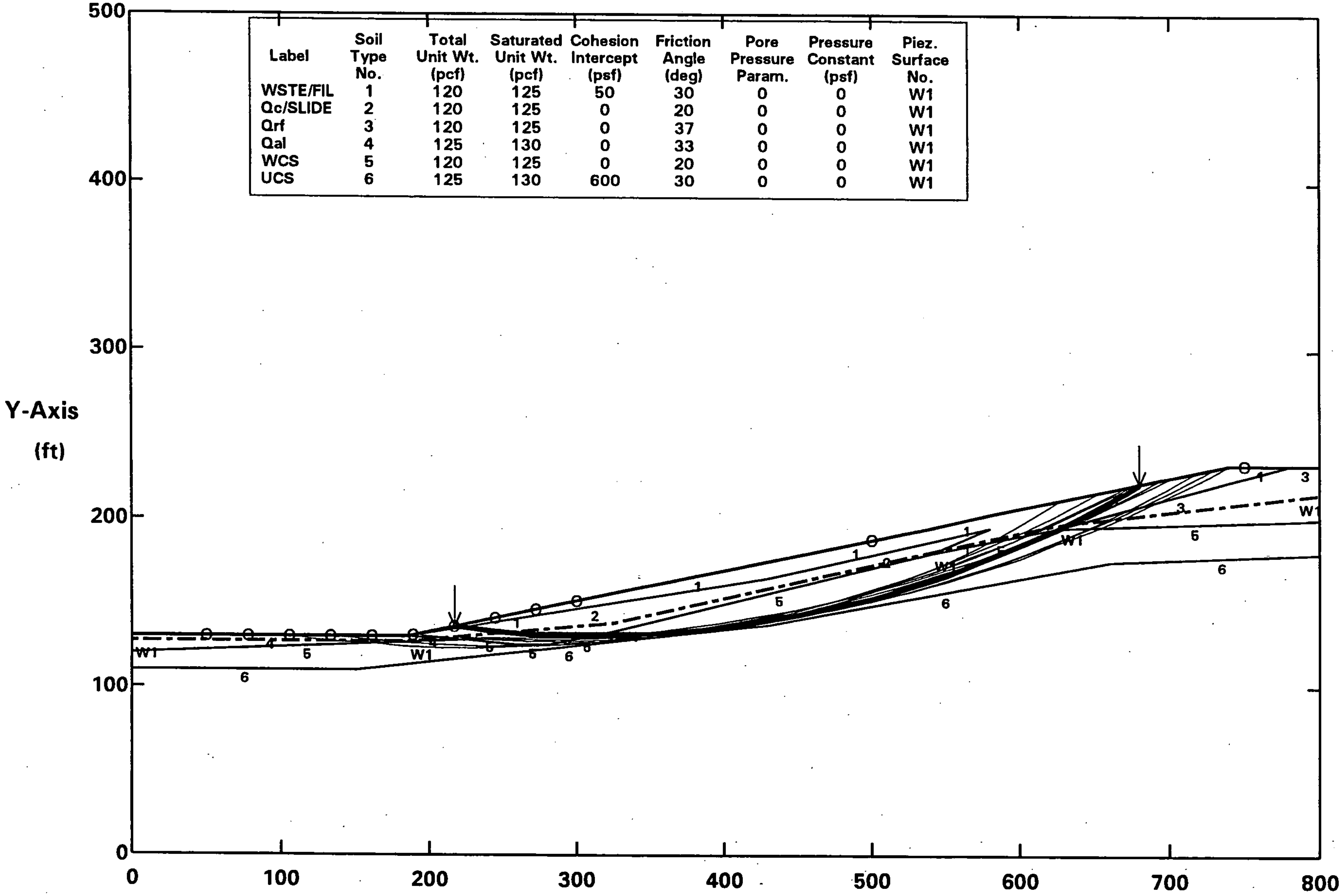
18% REGRADE CONDITION

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:DGACS.PLT By: STAN KLINE 10-24-04 2:17am



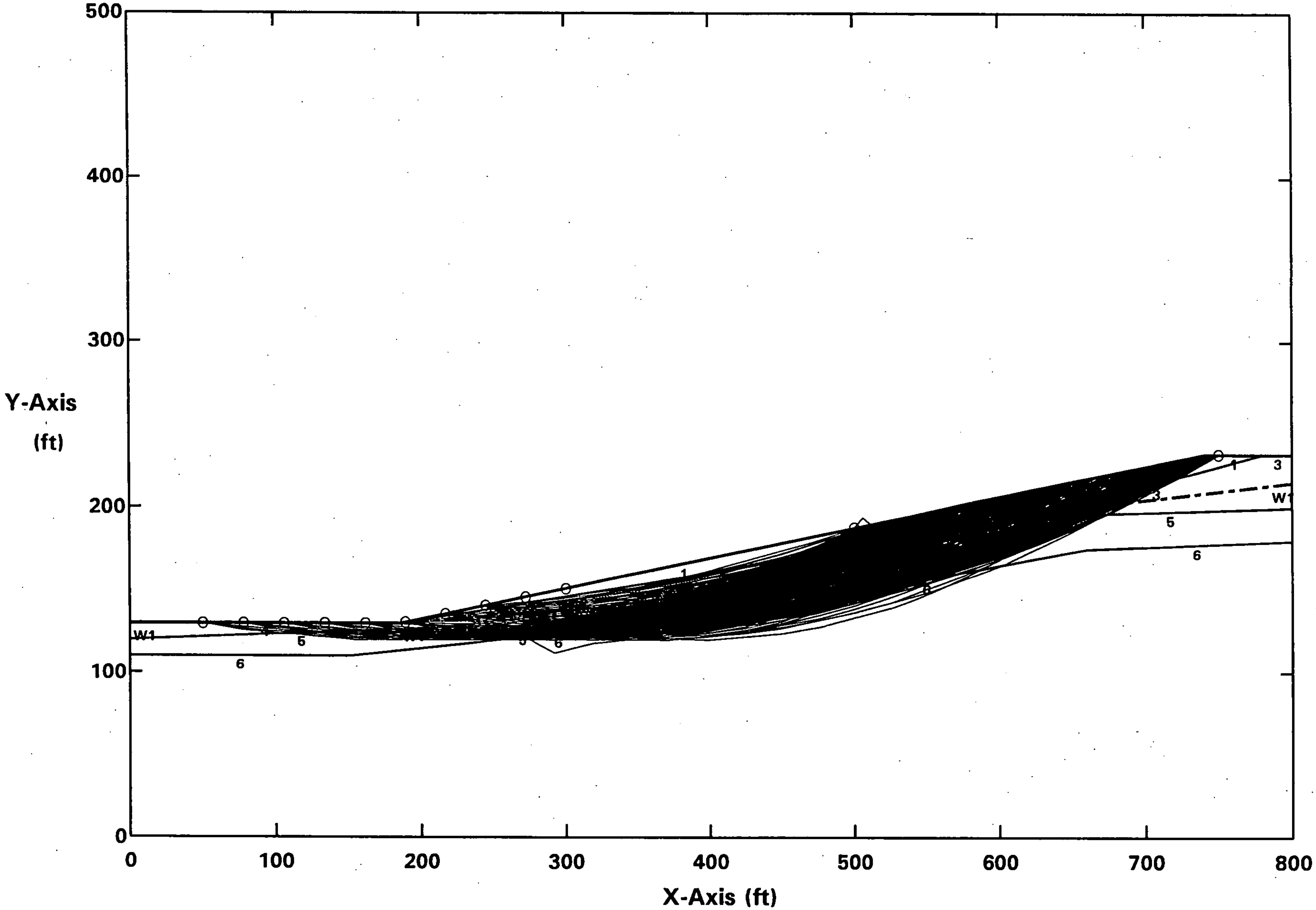
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS=20 deg - W/AVEGW - CIRCULAR - STATIC
Ten Most Critical. C:DGACS.PLT By: STAN KLINE 10-24-04 2:17am



PCSTABL5M/SI FSmin=1.65 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

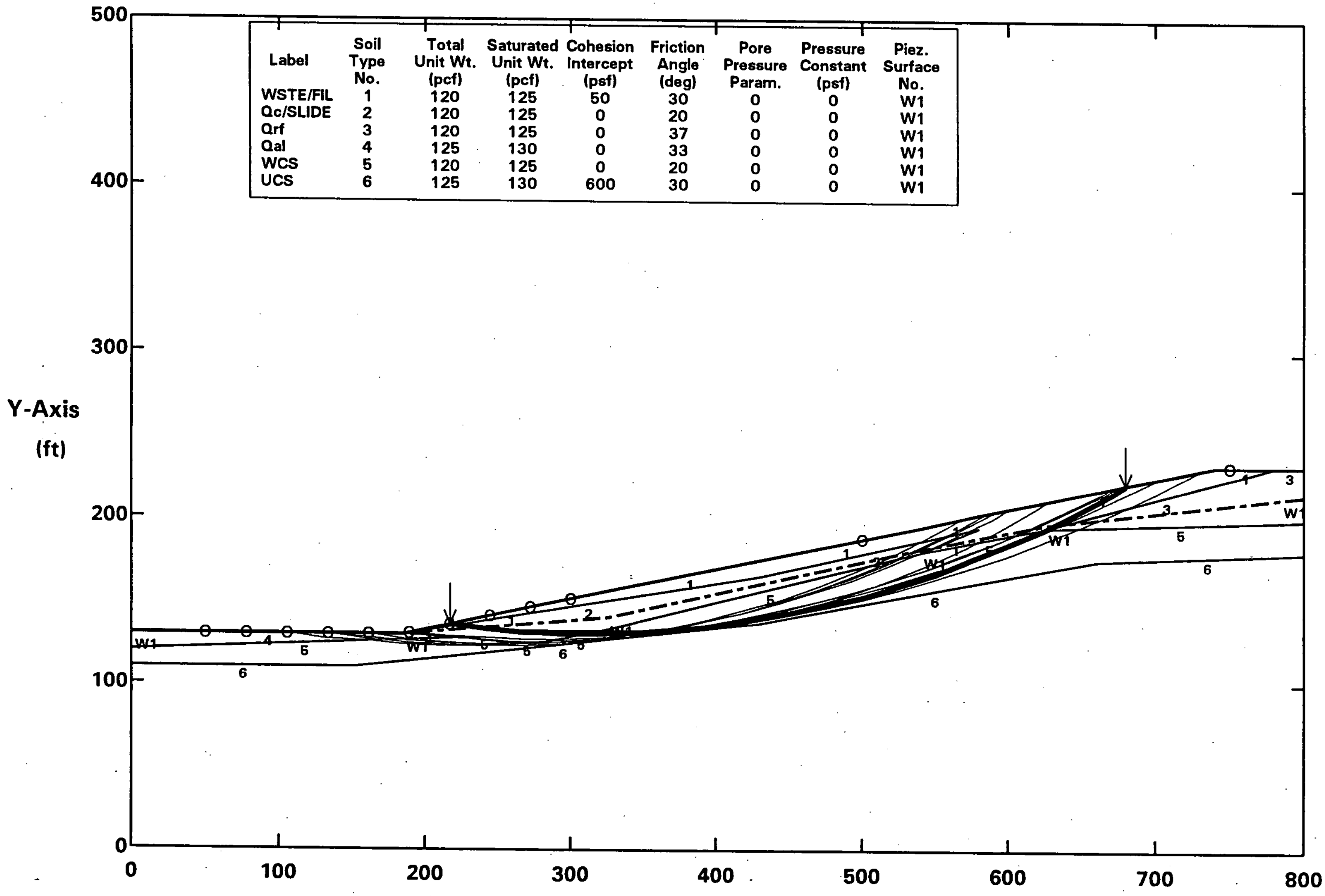
ROCKY FLATS OLF - M&E D 18% GRD - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:DGHCS.PLT By: STAN KLINE 10-24-04 1:17am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC

Ten Most Critical. C:DGHCS.PLT By: STAN KLINE 10-24-04 1:17am

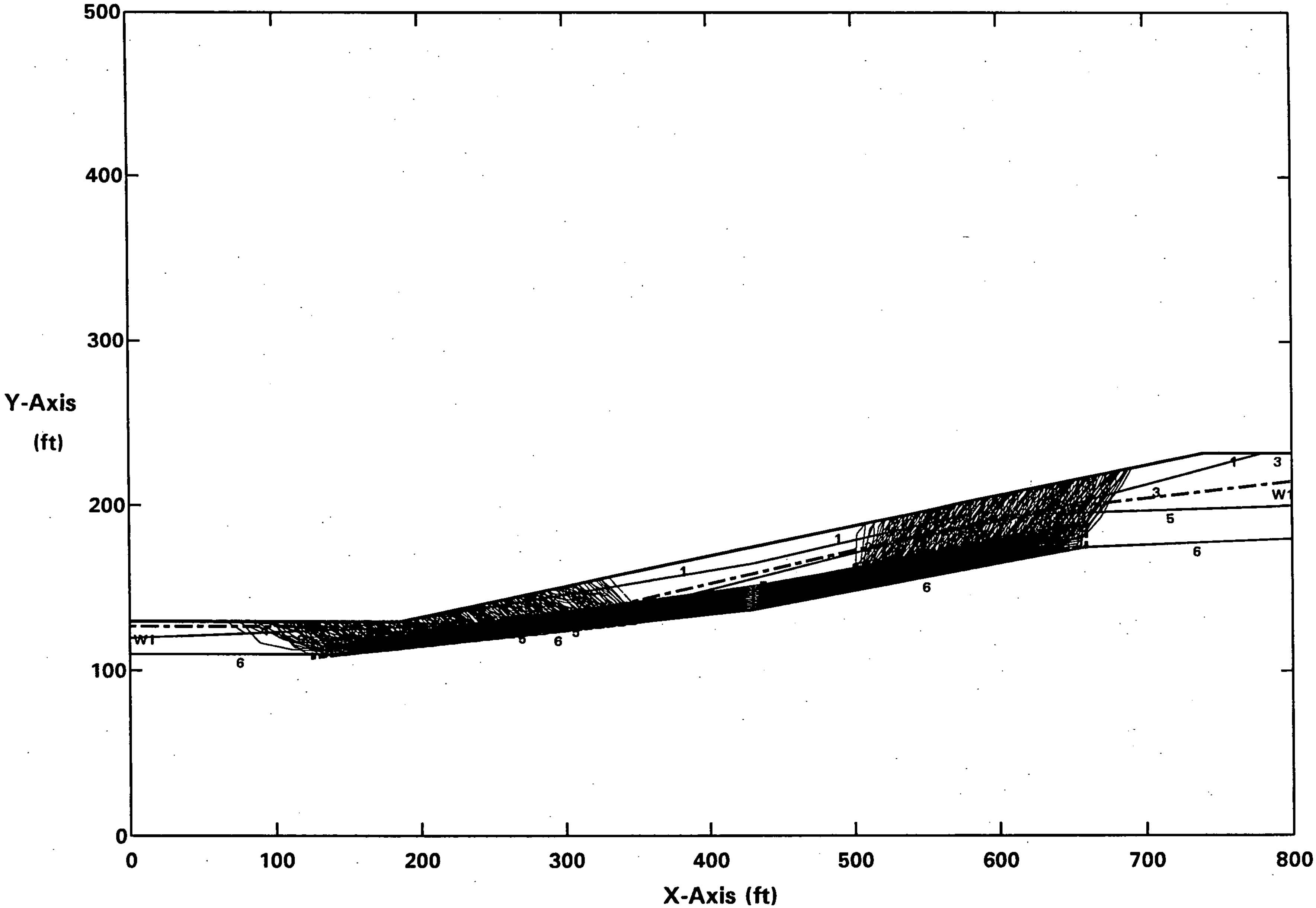


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 1.60 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

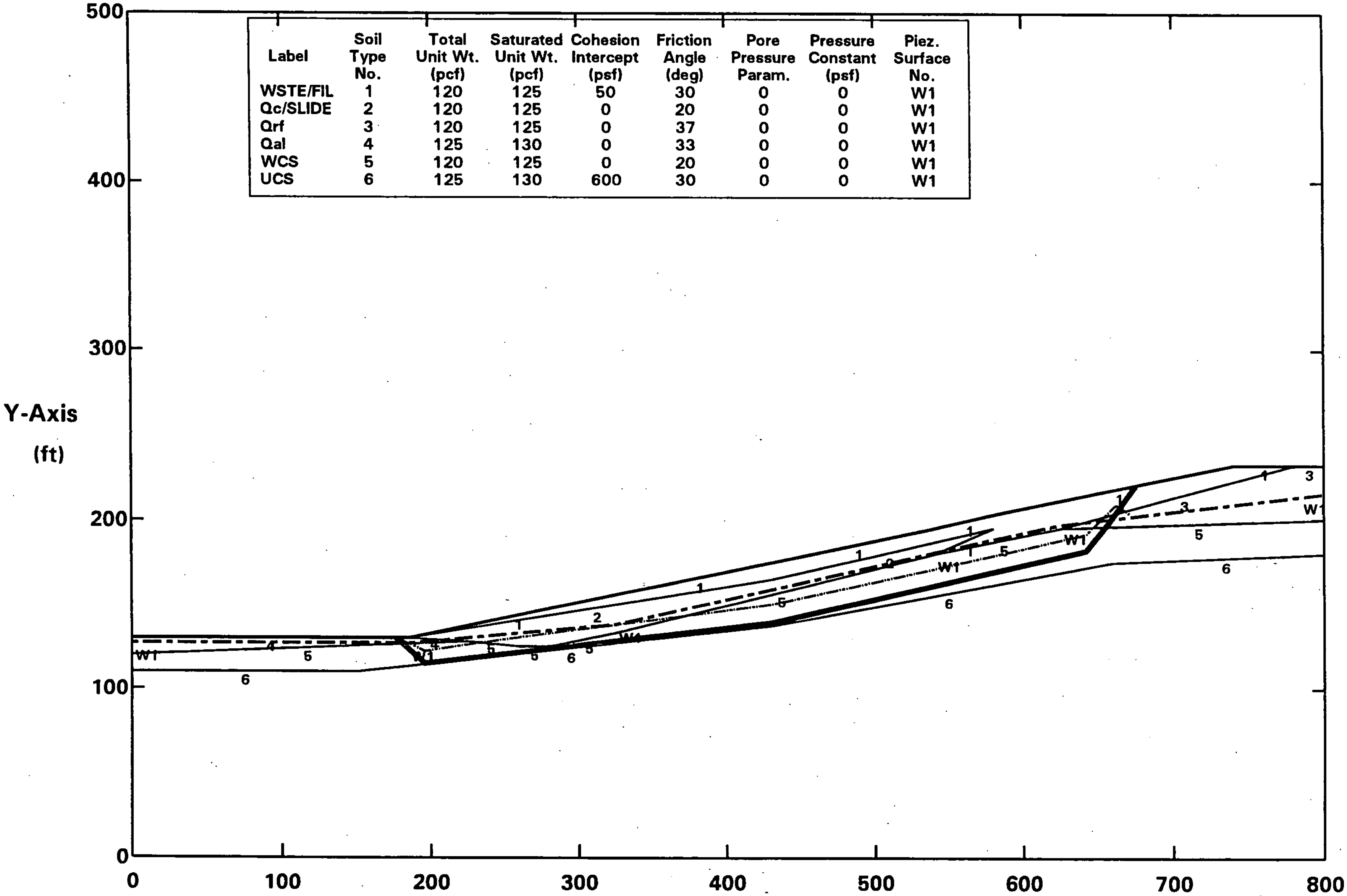
ROCKY FLATS OLF - M&E D 18% GRD - WCS = 20 deg - W/AVEGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:DGASS.PLT By: STAN KLINE 10-24-04 2:24am



Factors Of Safety Calculated By The Modified Janbu Method

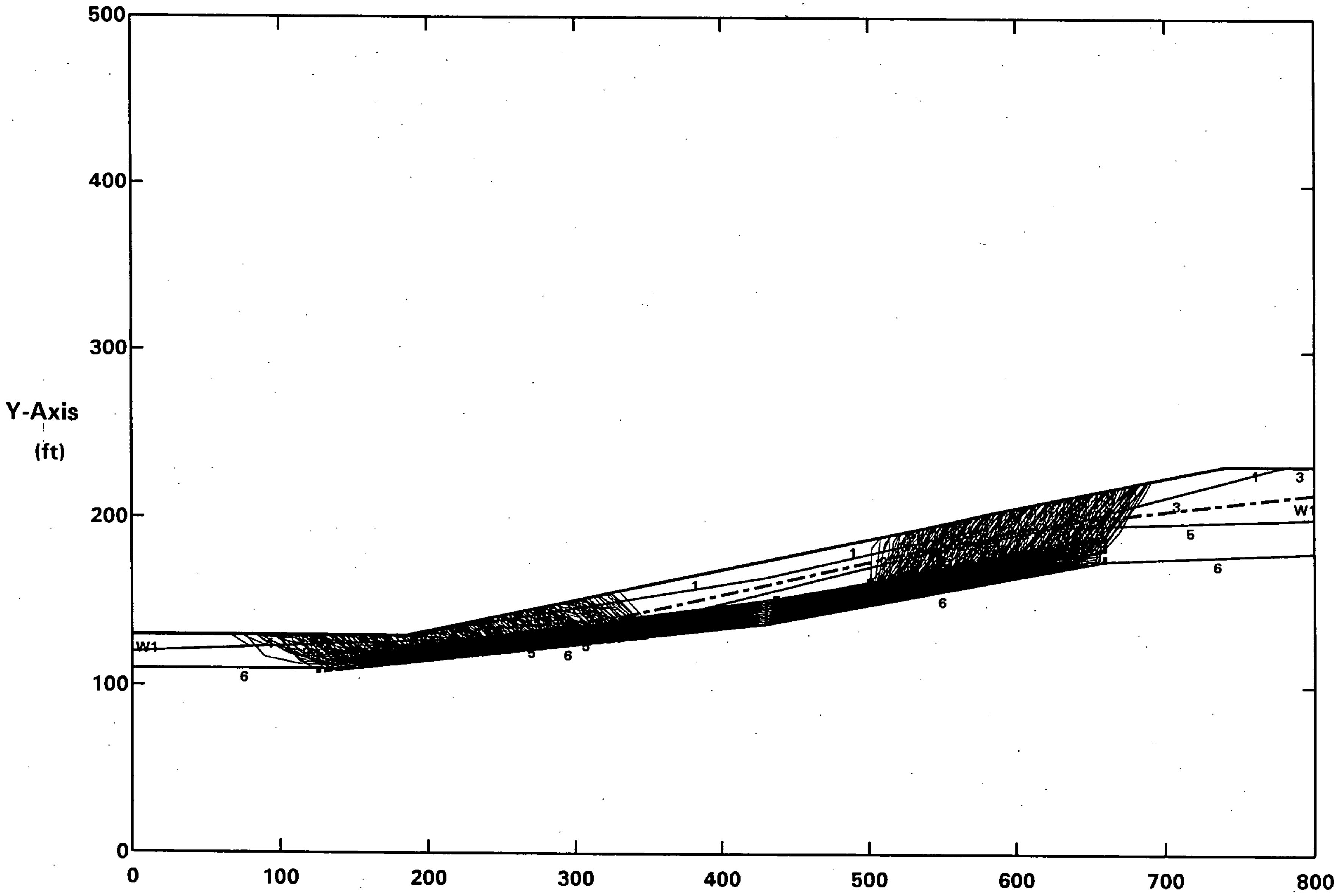
ROCKY FLATS OLF - M&E D 18% GRD - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-DGASS.OUT. C:DGASSSP.PLT By: STAN KLINE 10-24-04 2:26am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1



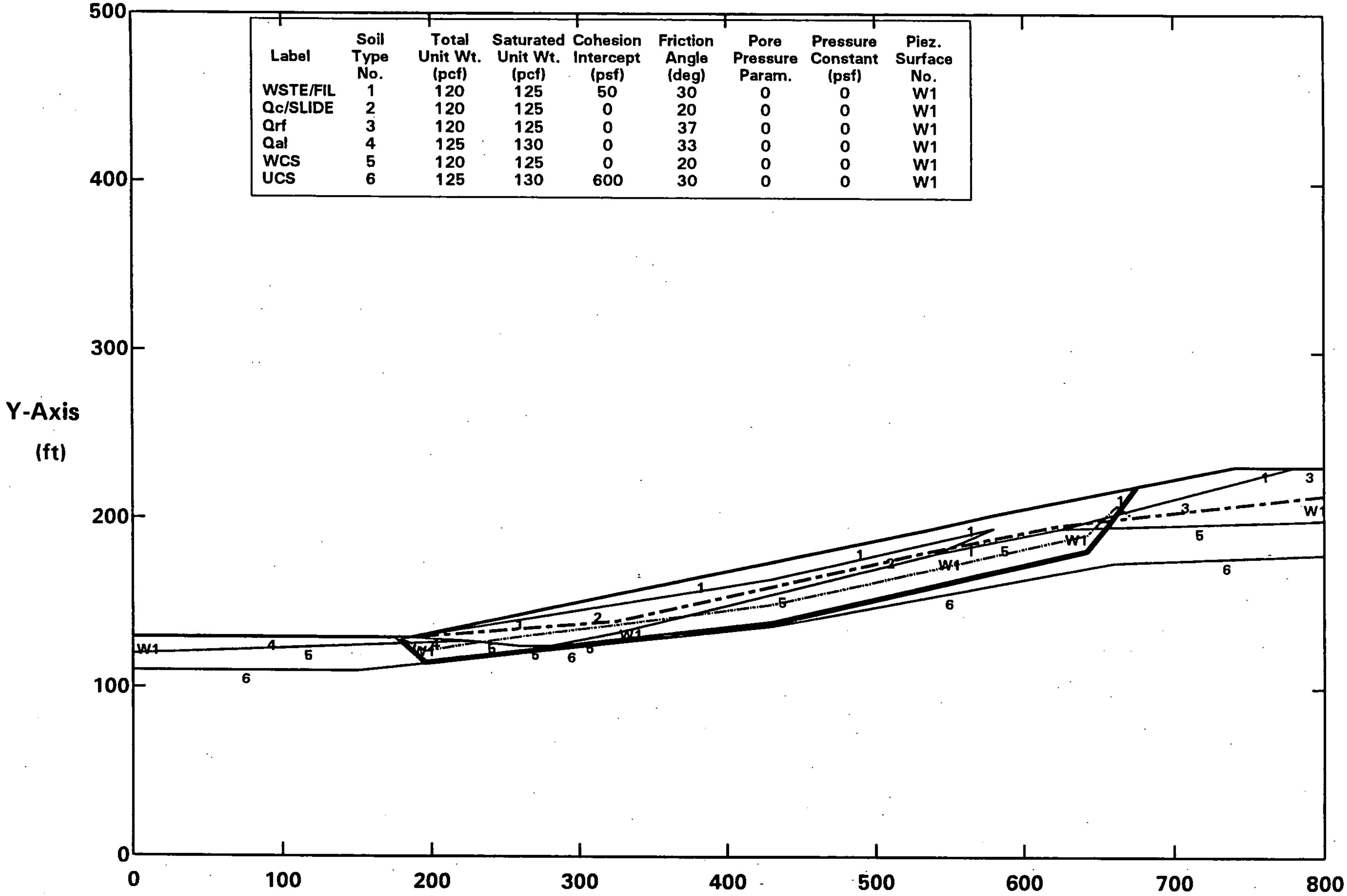
PCSTABL5M/SI FS=1.61 Theta=9.29 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E D 18% GRD - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:DGHSS.PLT By: STAN KLINE 10-23-04 11:19pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-DGHSS.OUT. C:DGHSSSP.PLT By: STAN KLINE 10-23-04 11:21pm

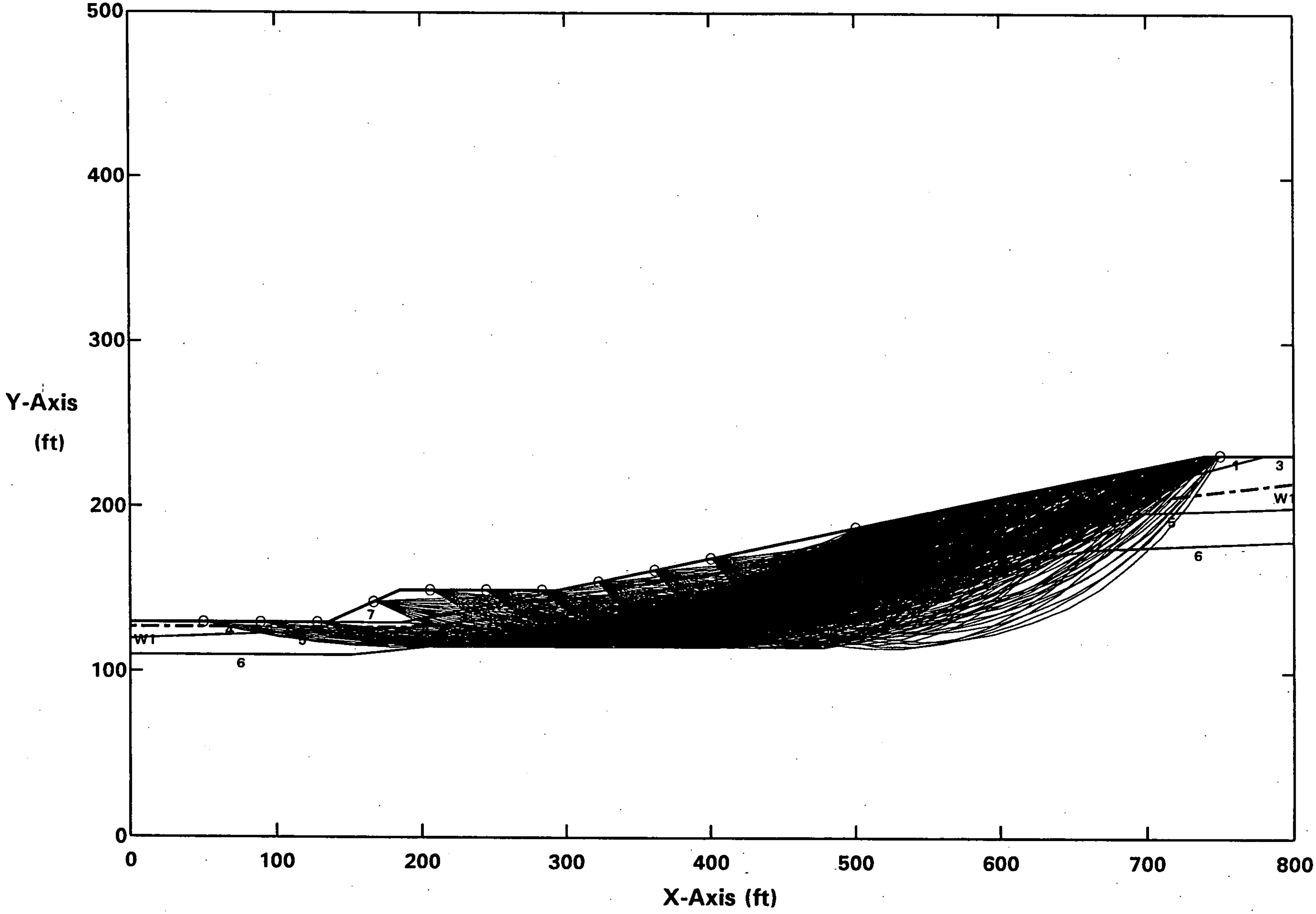


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS=1.55 Theta=9.36 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

18% REGRADE WITH BUTTRESS CONDITION

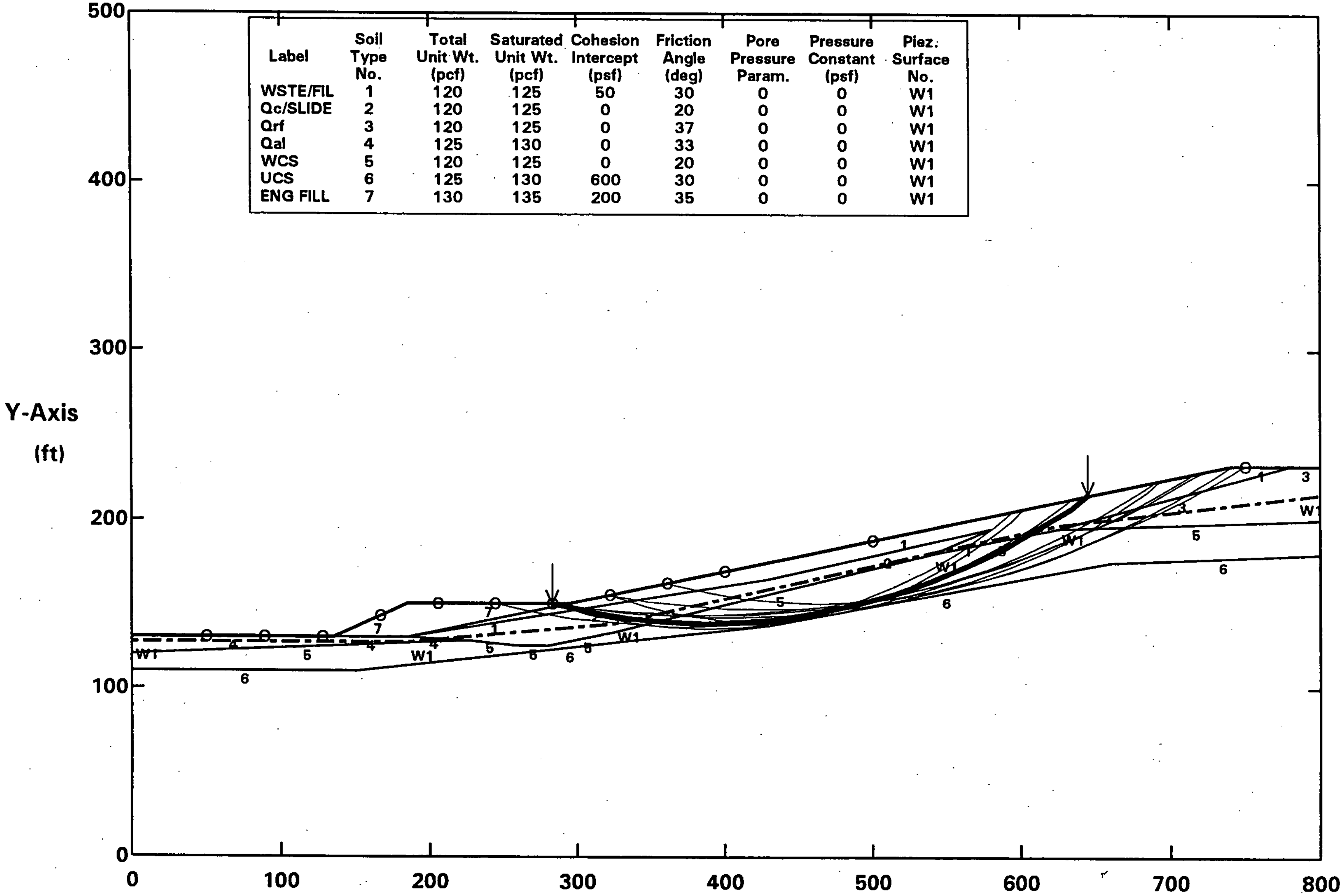
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=20 deg - W/AVEGW - CIRCULAR - STATIC
All surfaces evaluated. C:DBACS.PLT By: STAN KLINE 10-24-04 2:14am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS=20 deg - W/AVEGW - CIRCULAR - STATIC

Ten Most Critical. C:DBACS.PLT By: STAN KLINE 10-24-04 2:14am

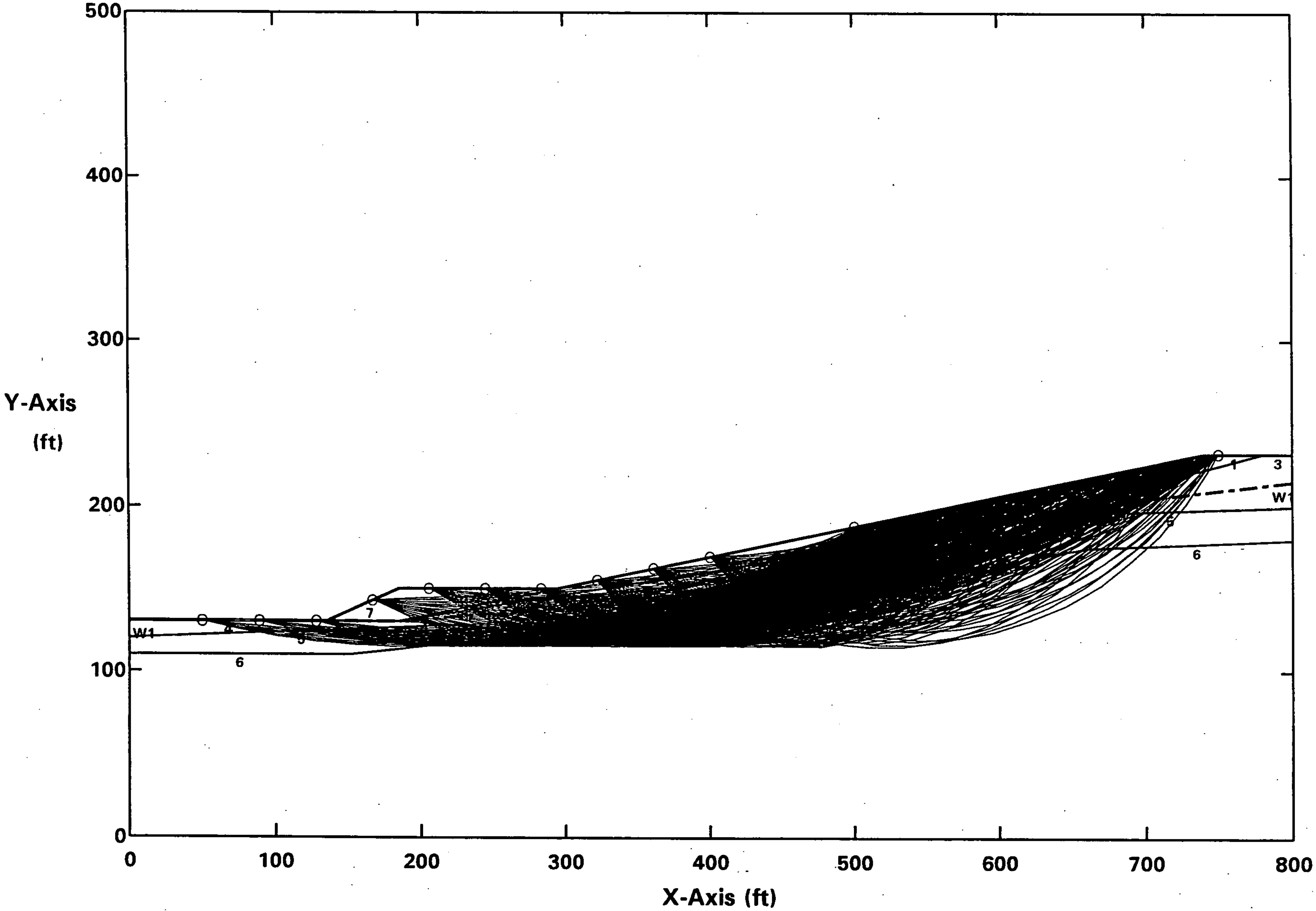


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FSmin=1.70 X-Axis (ft)

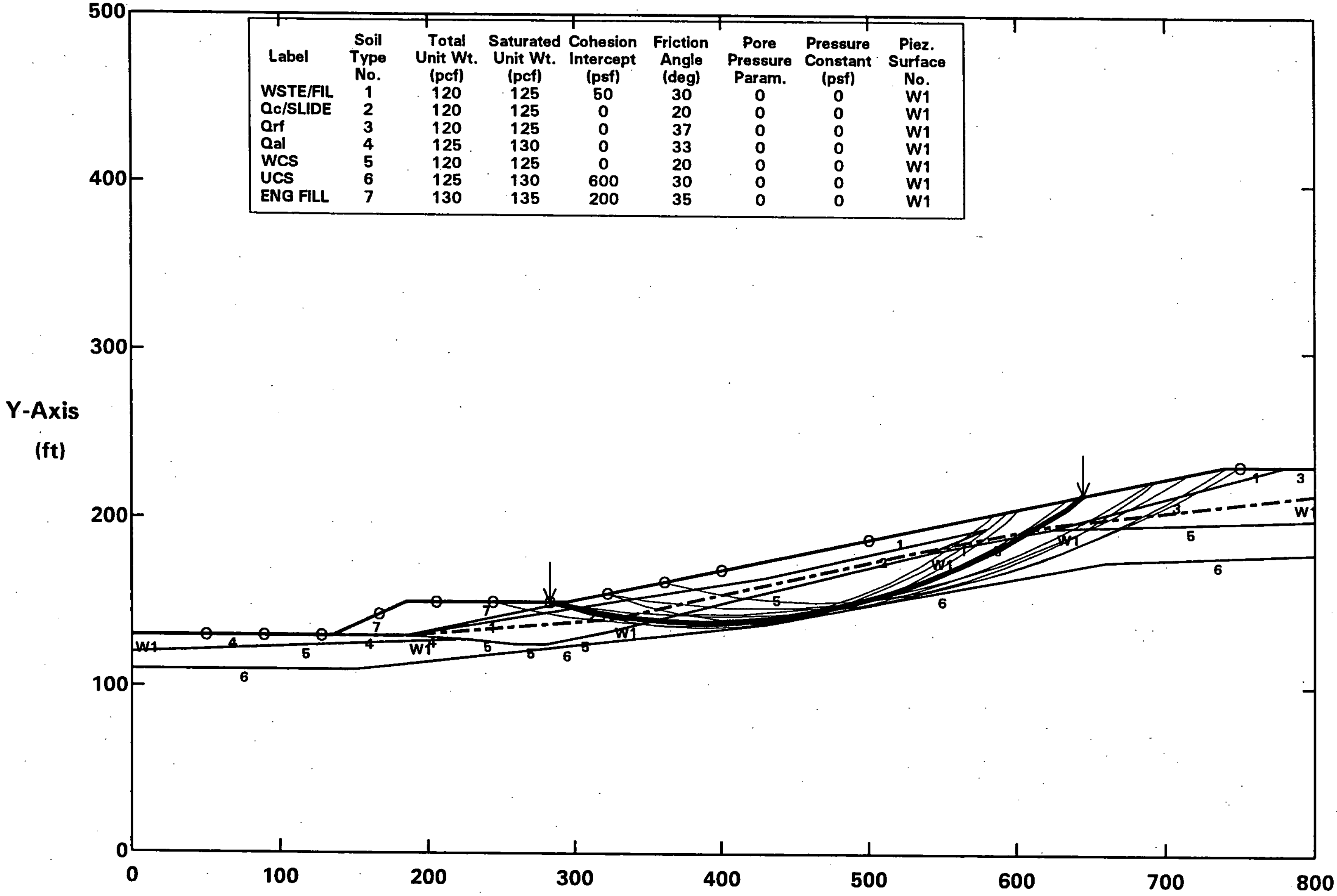
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
All surfaces evaluated. C:DBHCS.PLT By: STAN KLINE 10-24-04 1:48am



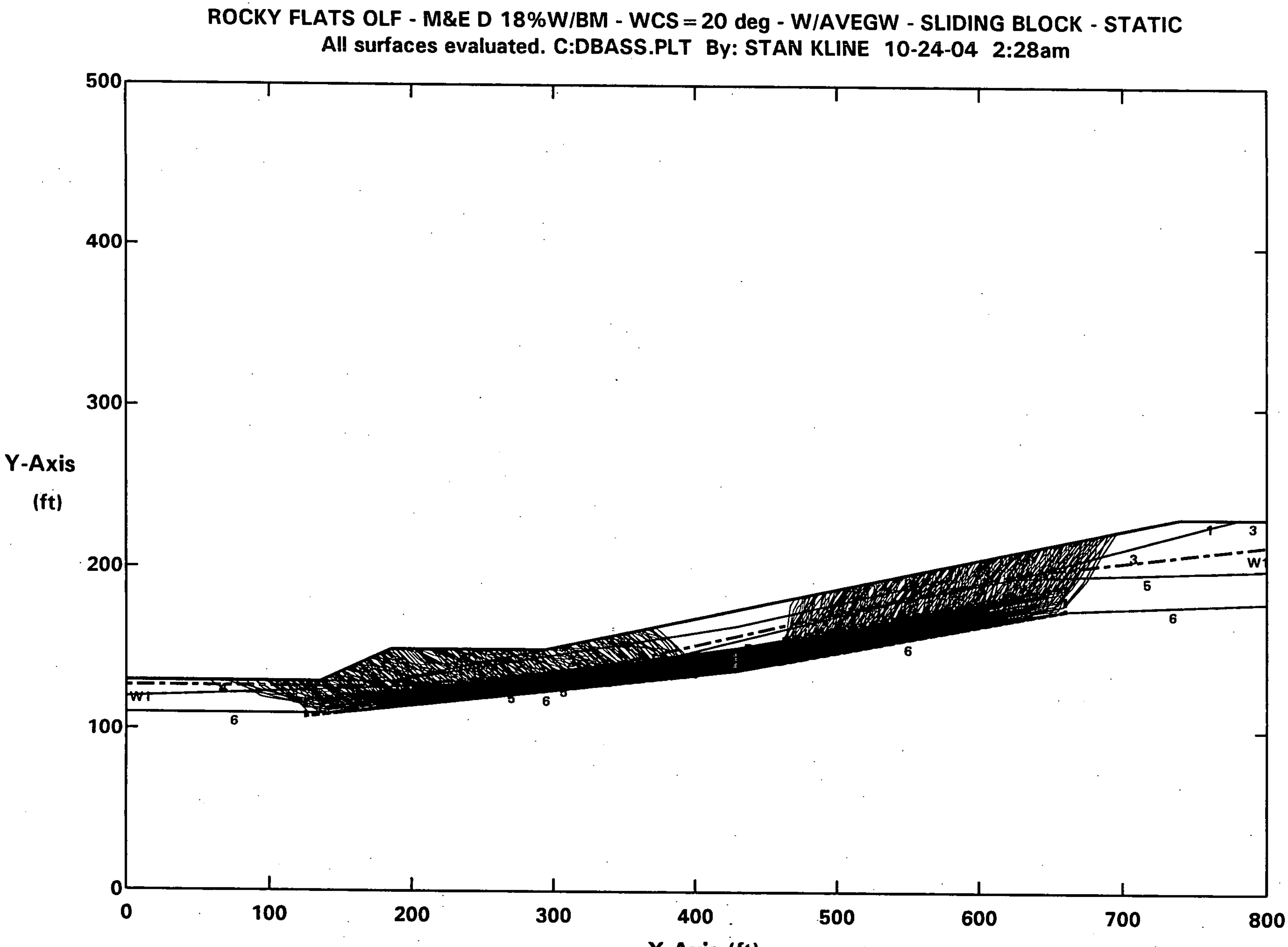
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS = 20 deg - W/HIGHGW - CIRCULAR - STATIC
Ten Most Critical. C:DBHCS.PLT By: STAN KLINE 10-24-04 1:48am



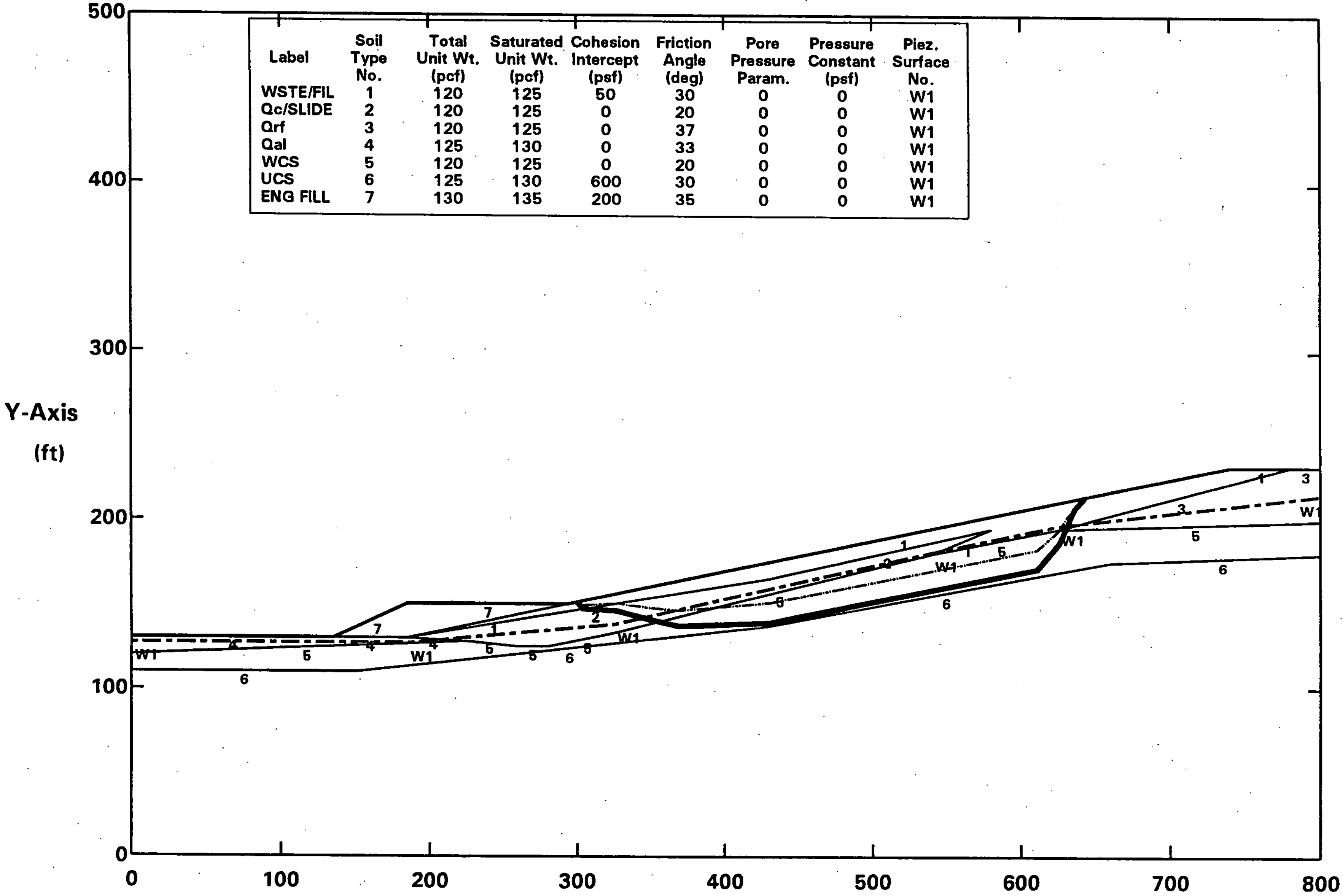
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FSmin = 1.66 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method



Factors Of Safety Calculated By The Modified Janbu Method

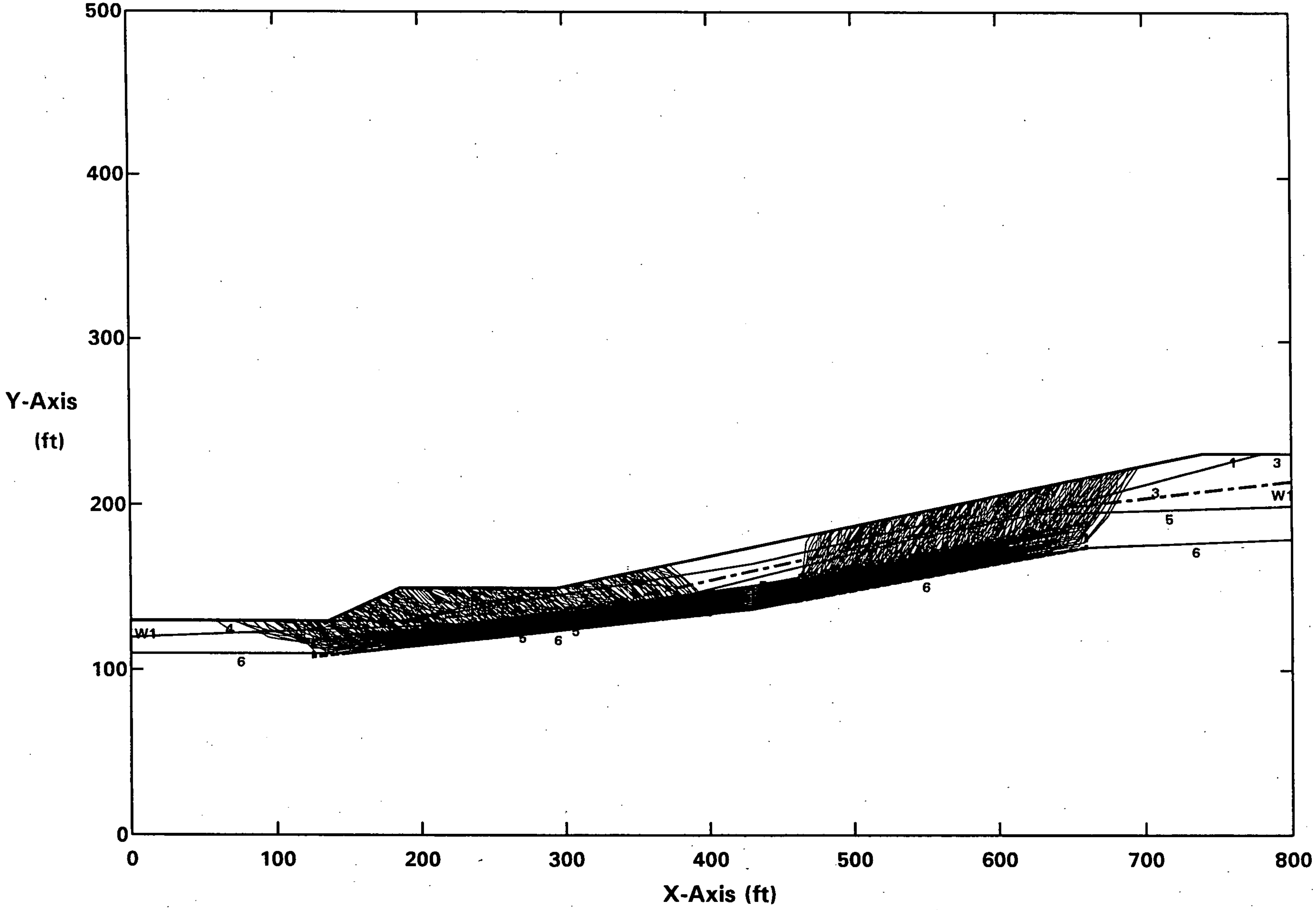
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=20 deg - W/AVEGW - SLIDING BLOCK - STATIC
Surface #1-DBASS.OUT. C:DBASSSP.PLT By: STAN KLINE 10-24-04 2:30am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

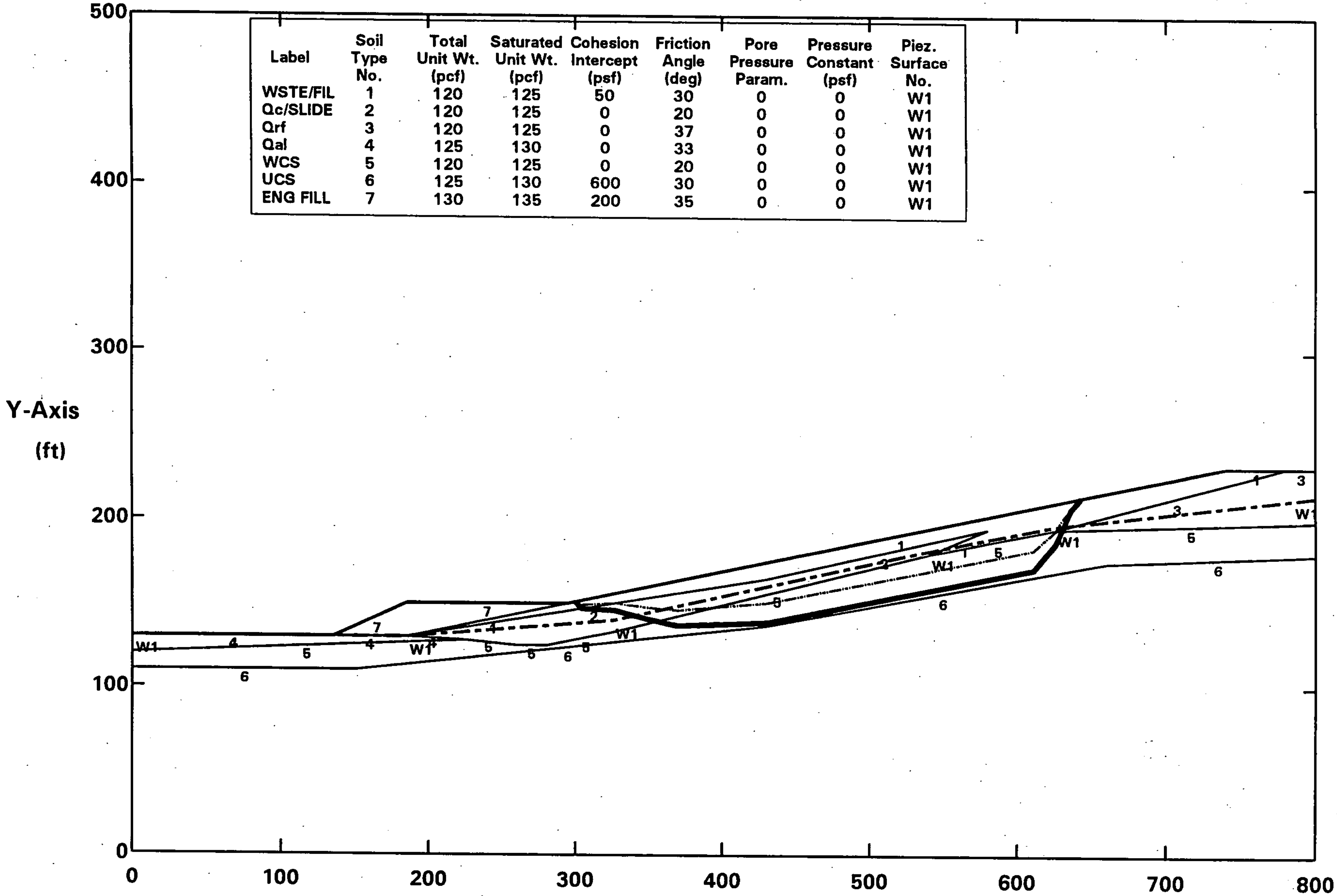
PCSTABL5M/SI FS=1.71 Theta=8.77 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E D 18%W/BM - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
All surfaces evaluated. C:DBHSS.PLT By: STAN KLINE 10-23-04 11:58pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS=20 deg - W/HIGHGW - SLIDING BLOCK - STATIC
Surface #1-DBHSS.OUT. C:DBHSSSP.PLT By: STAN KLINE 10-24-04 12:02am



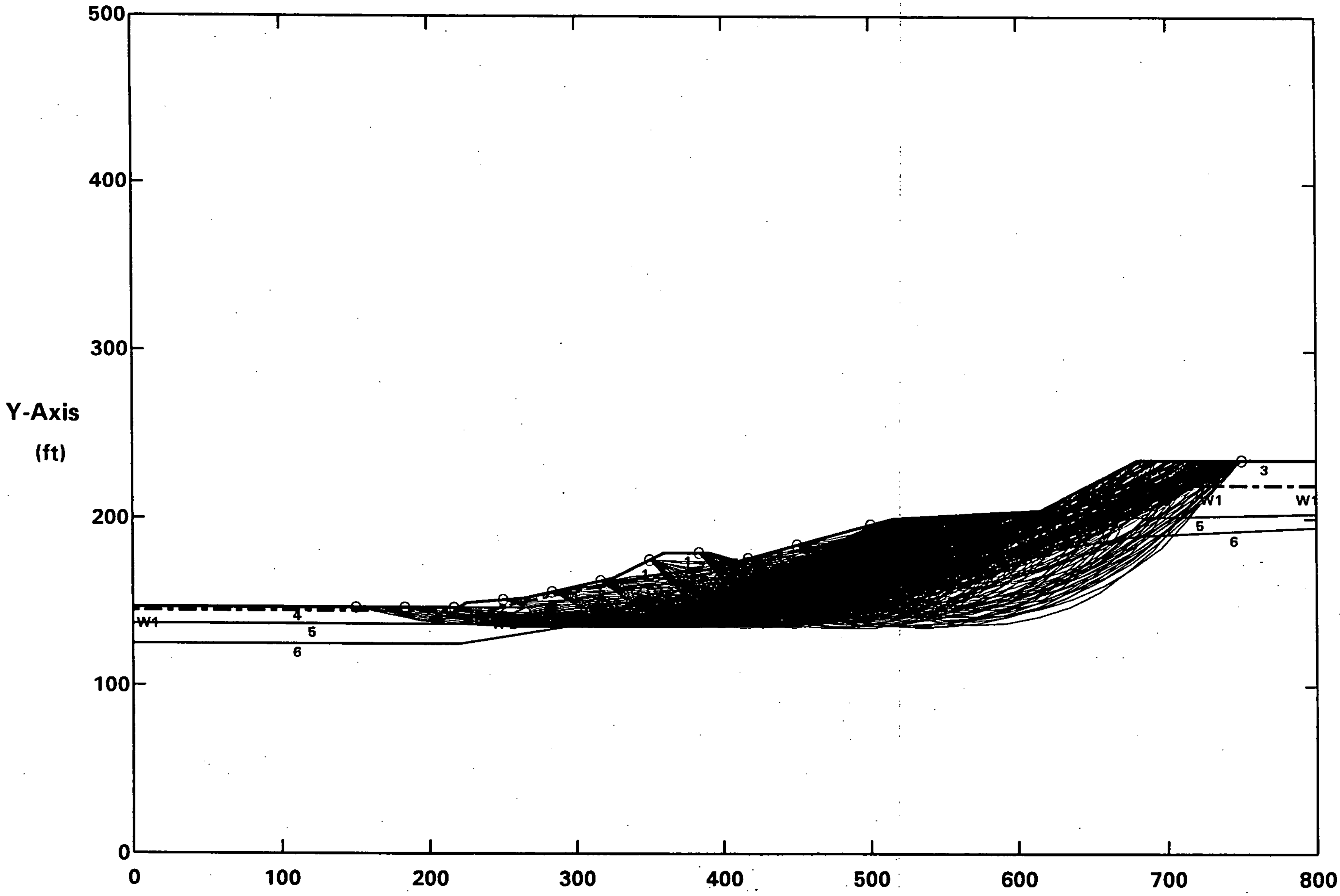
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	20	0	0	W1
Qrf	3	120	125	0	37	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	20	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FS=1.67 Theta=8.75 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

M&E SECTION B-B' – PSEUDOSTATIC

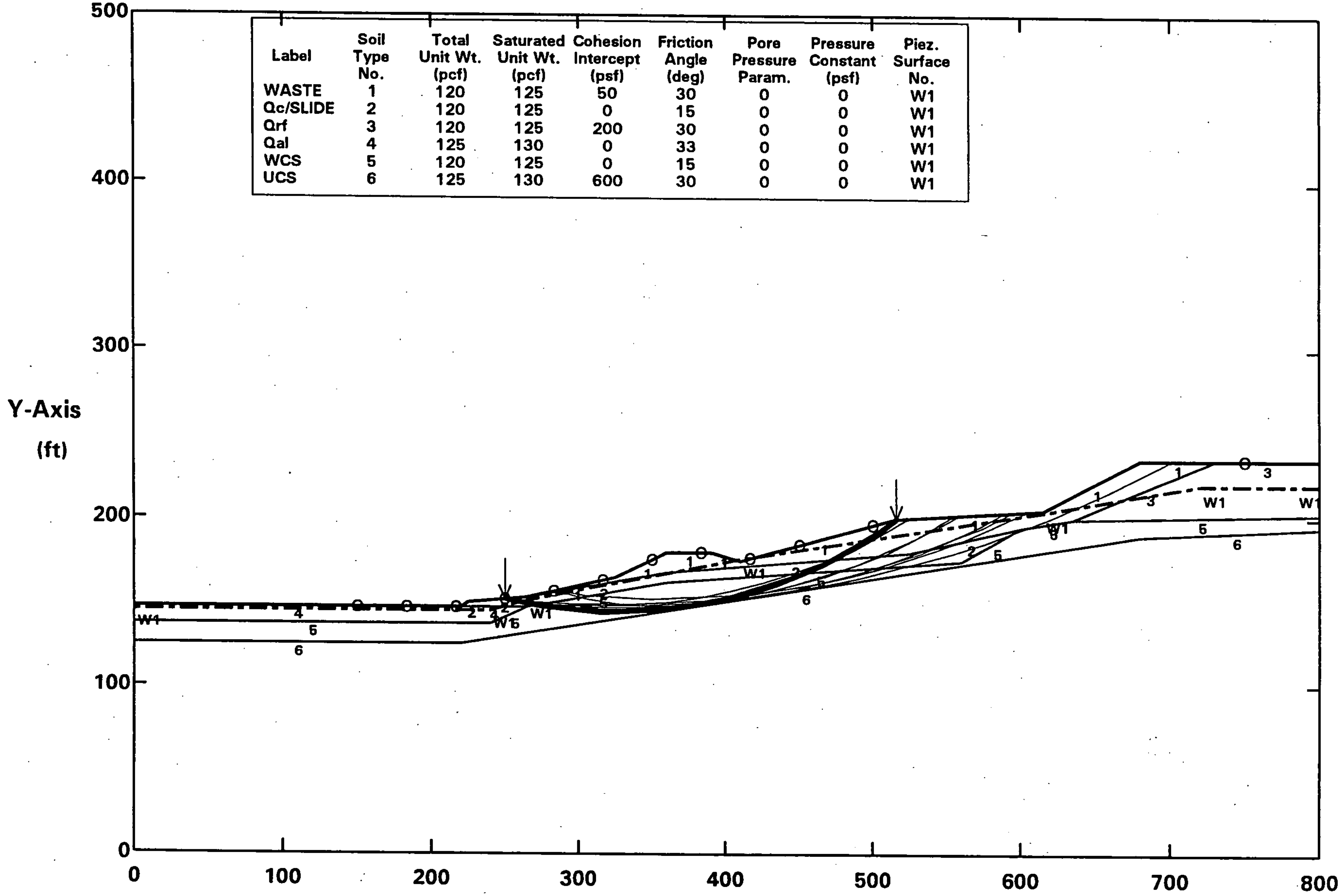
EXISTING CONDITIONS

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:BEAC06.PLT By: STAN KLINE 10-24-04 3:46am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:BEAC06.PLT By: STAN KLINE 10-24-04 3:46am

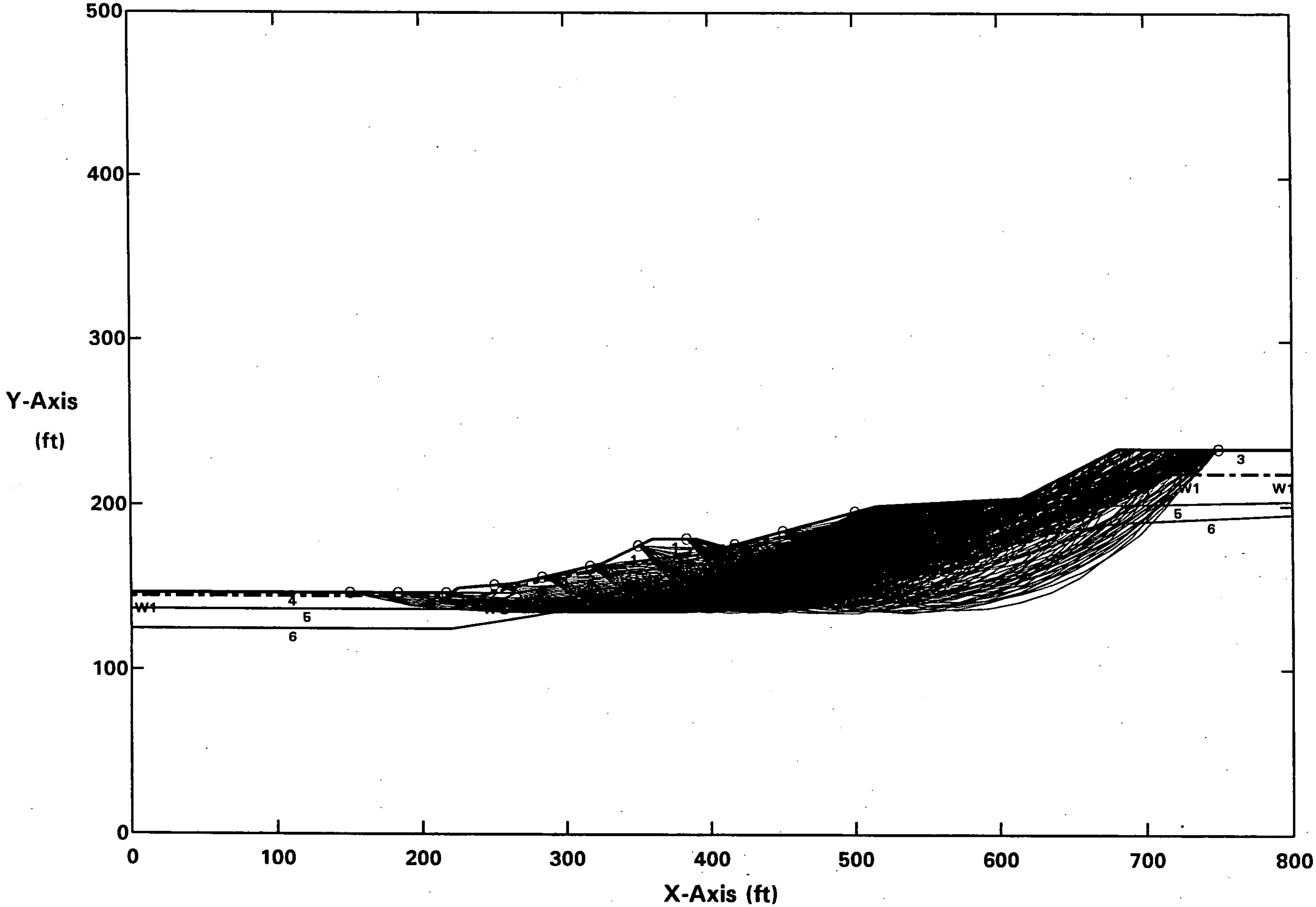


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 0.84 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

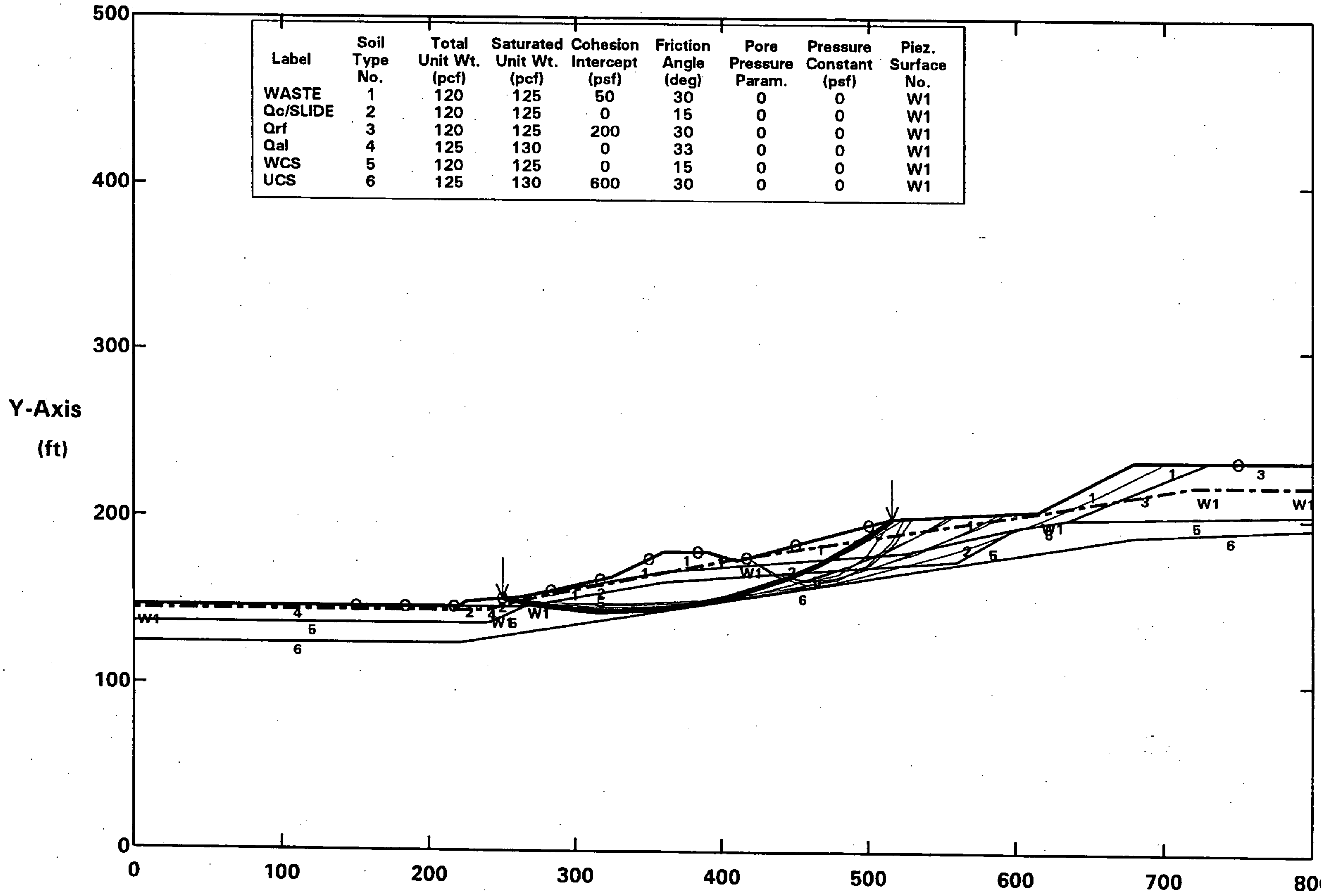
ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.02g
All surfaces evaluated. C:BEAC02.PLT By: STAN KLINE 10-24-04 3:45am



Factors Of Safety Calculated By The Modified Bishop Method

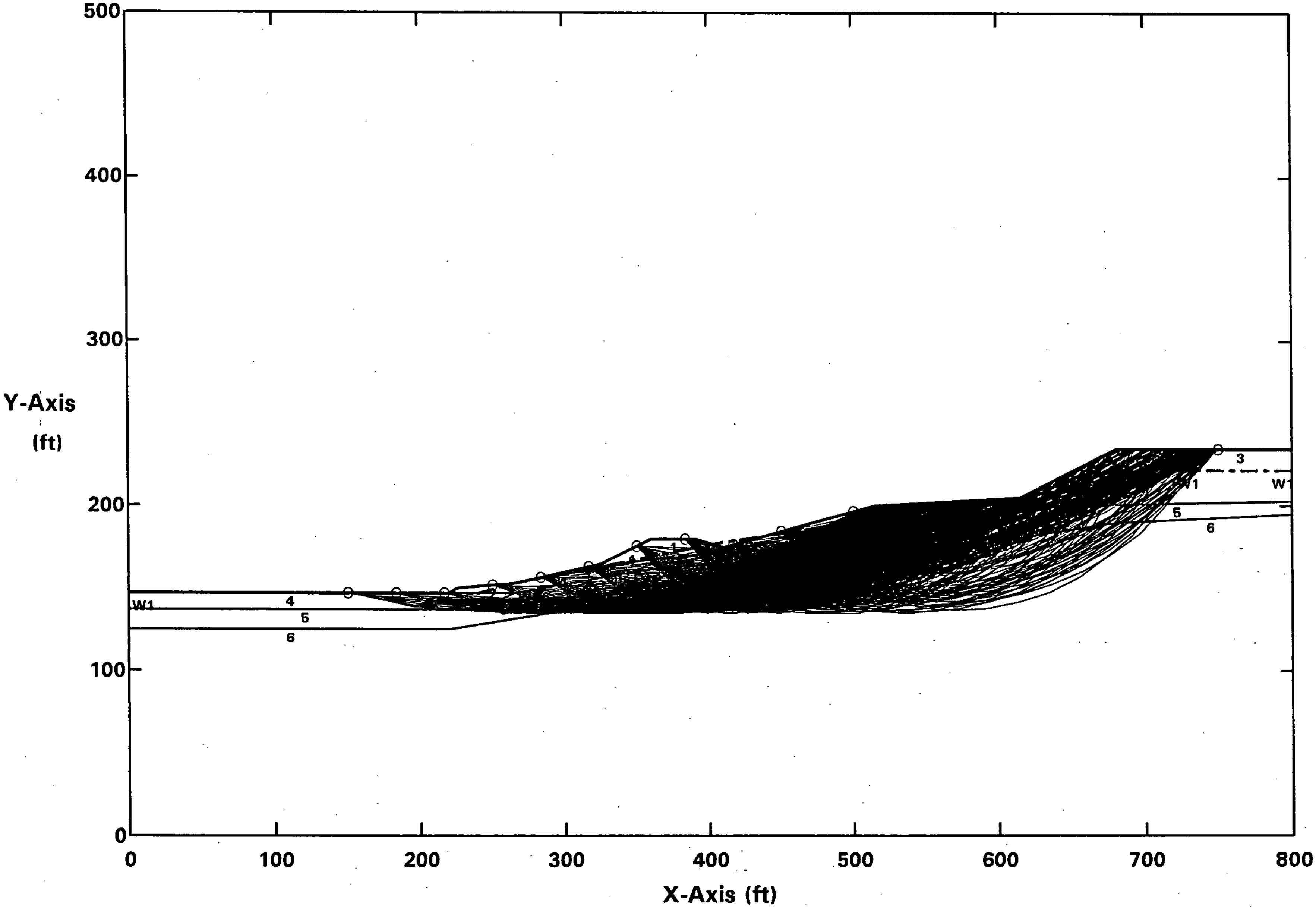
ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.02g
Ten Most Critical. C:BEAC02.PLT By: STAN KLINE 10-24-04 3:45am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



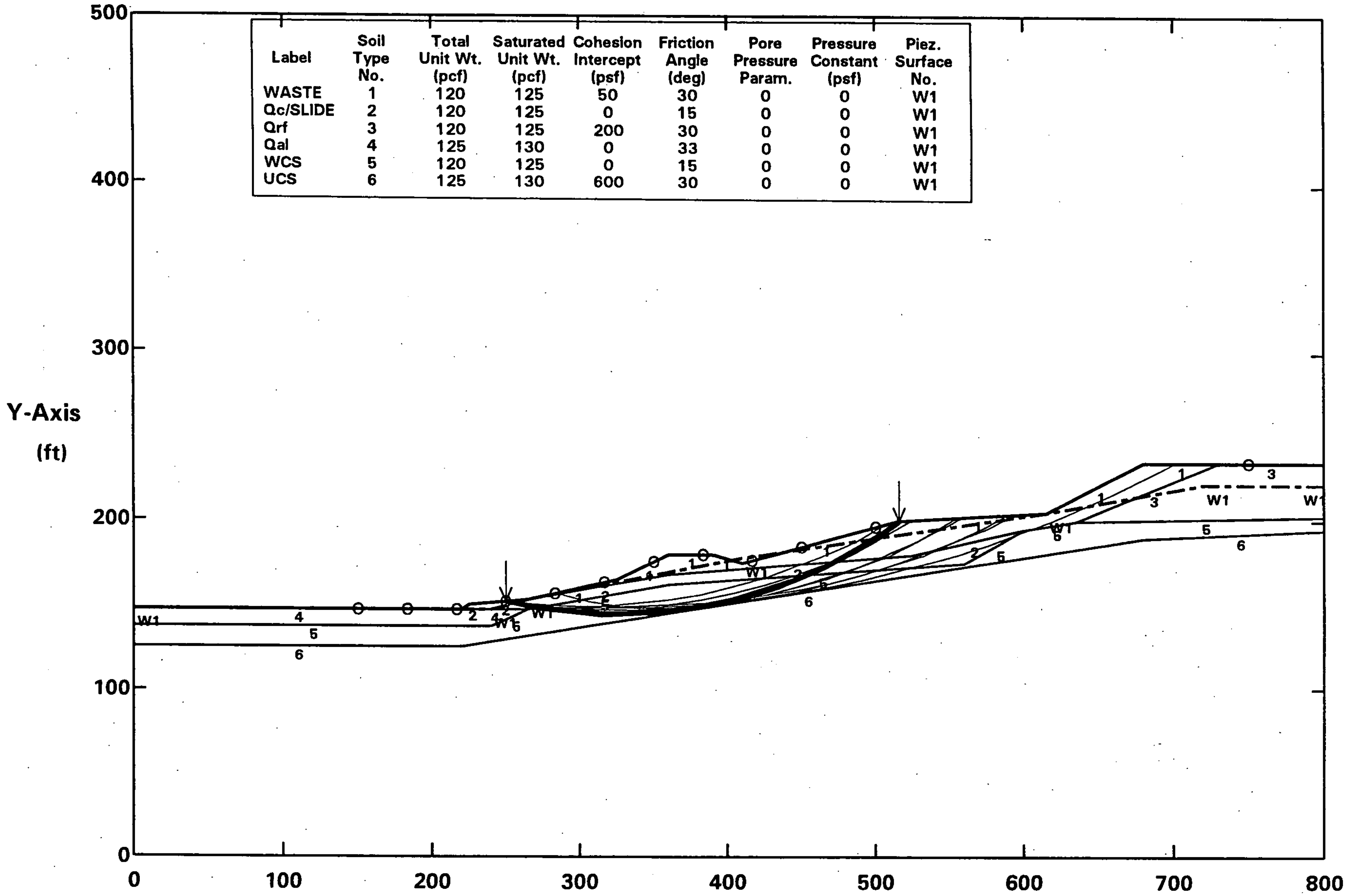
PCSTABL5M/SI FSmin = 1.04 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
All surfaces evaluated. C:BEHC06.PLT By: STAN KLINE 10-26-04 12:05am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:BEHC06.PLT By: STAN KLINE 10-26-04 12:05am

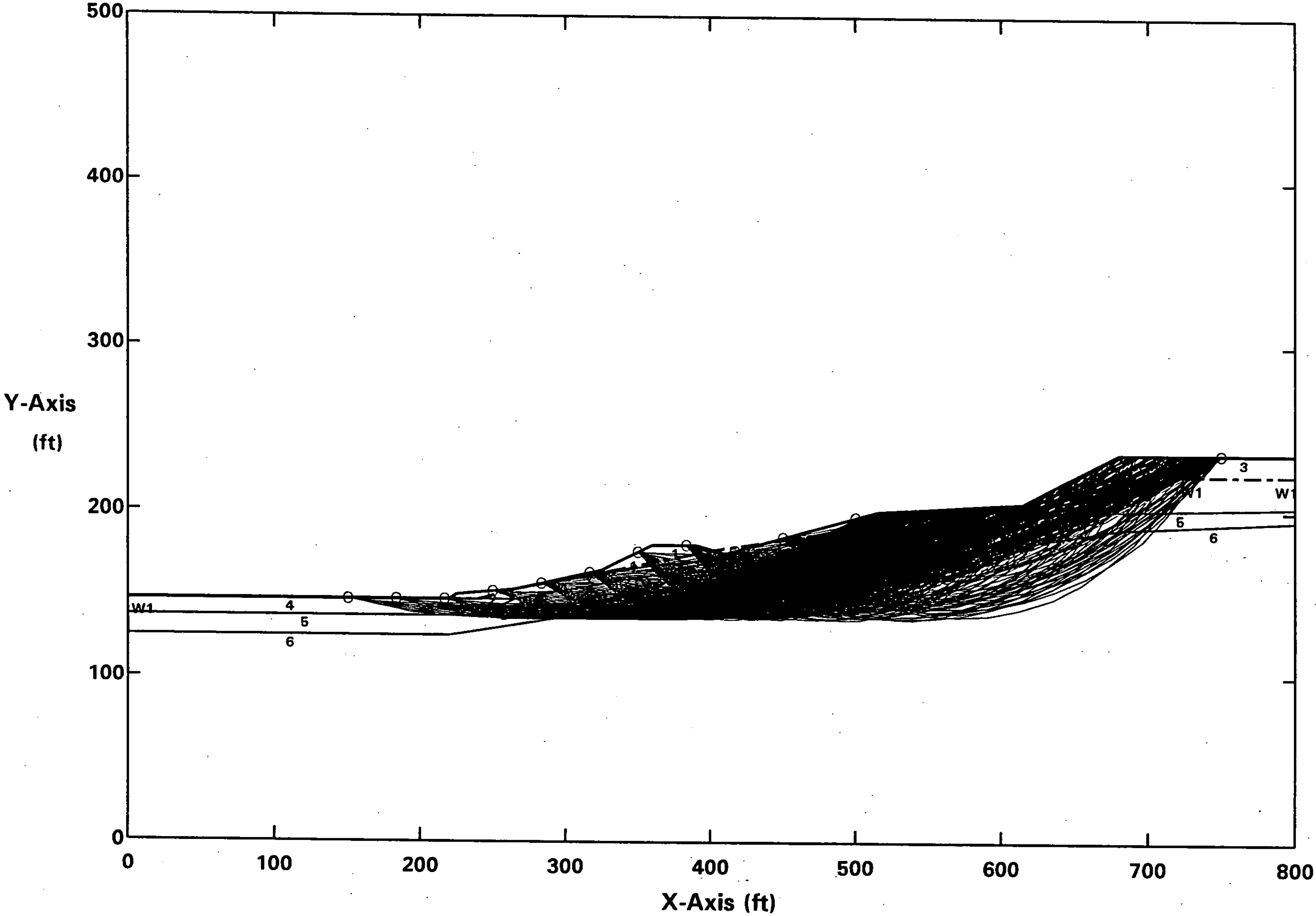


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 0.78 X-Axis (ft)

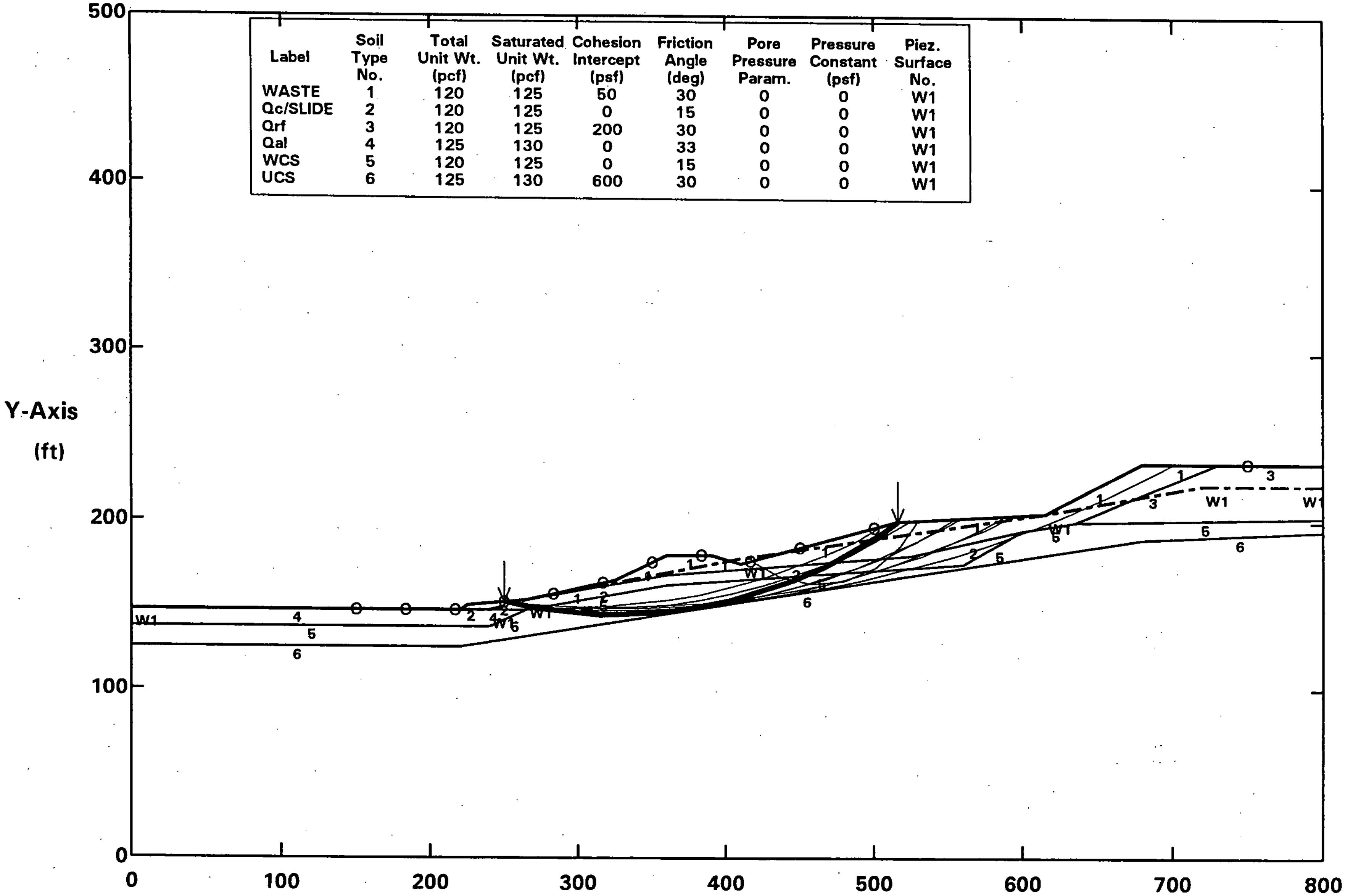
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.01g
All surfaces evaluated. C:BEHC01.PLT By: STAN KLINE 10-26-04 12:04am



Factors Of Safety Calculated By The Modified Bishop Method

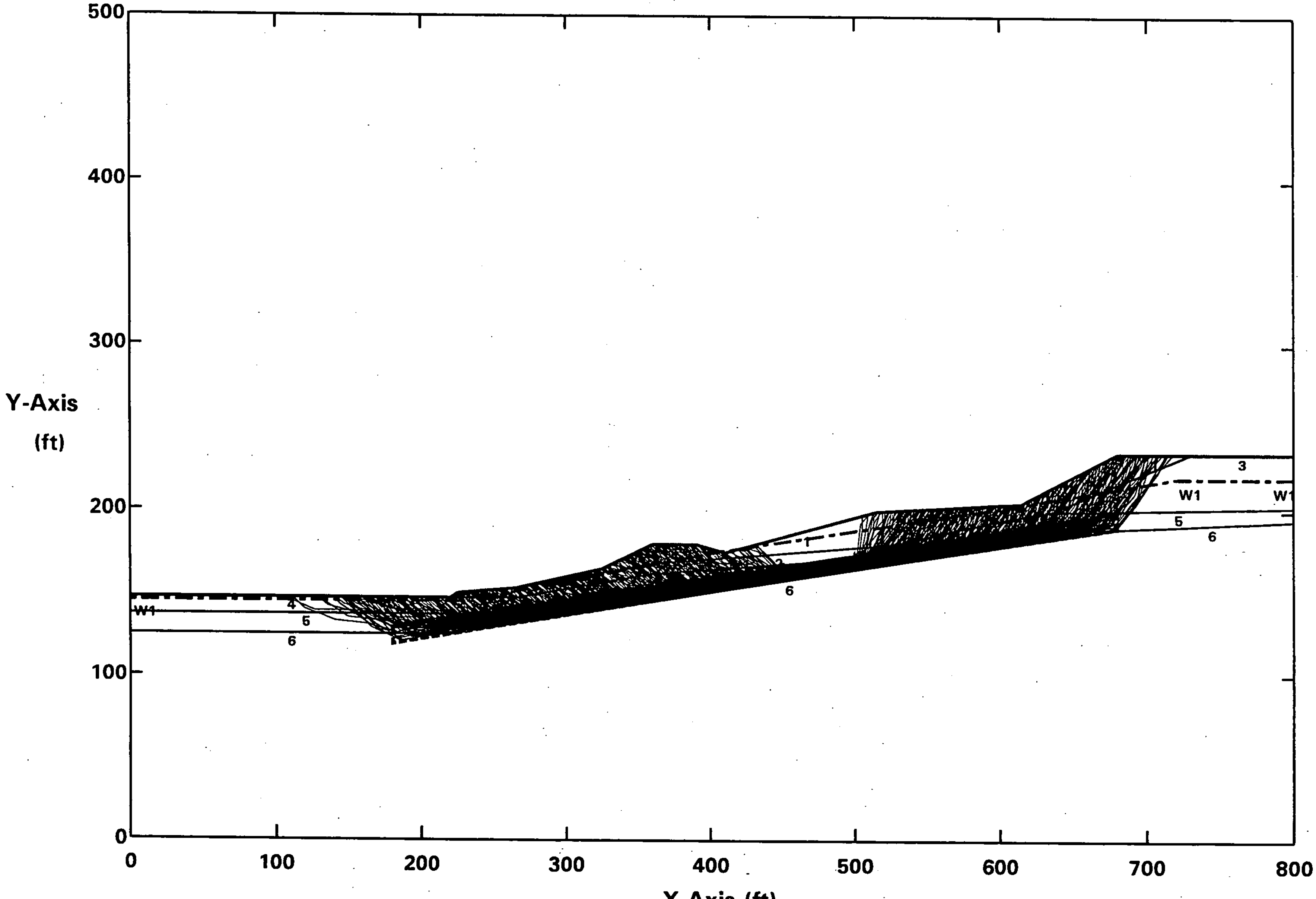
ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.01g
Ten Most Critical. C:BEHC01.PLT By: STAN KLINE 10-26-04 12:04am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

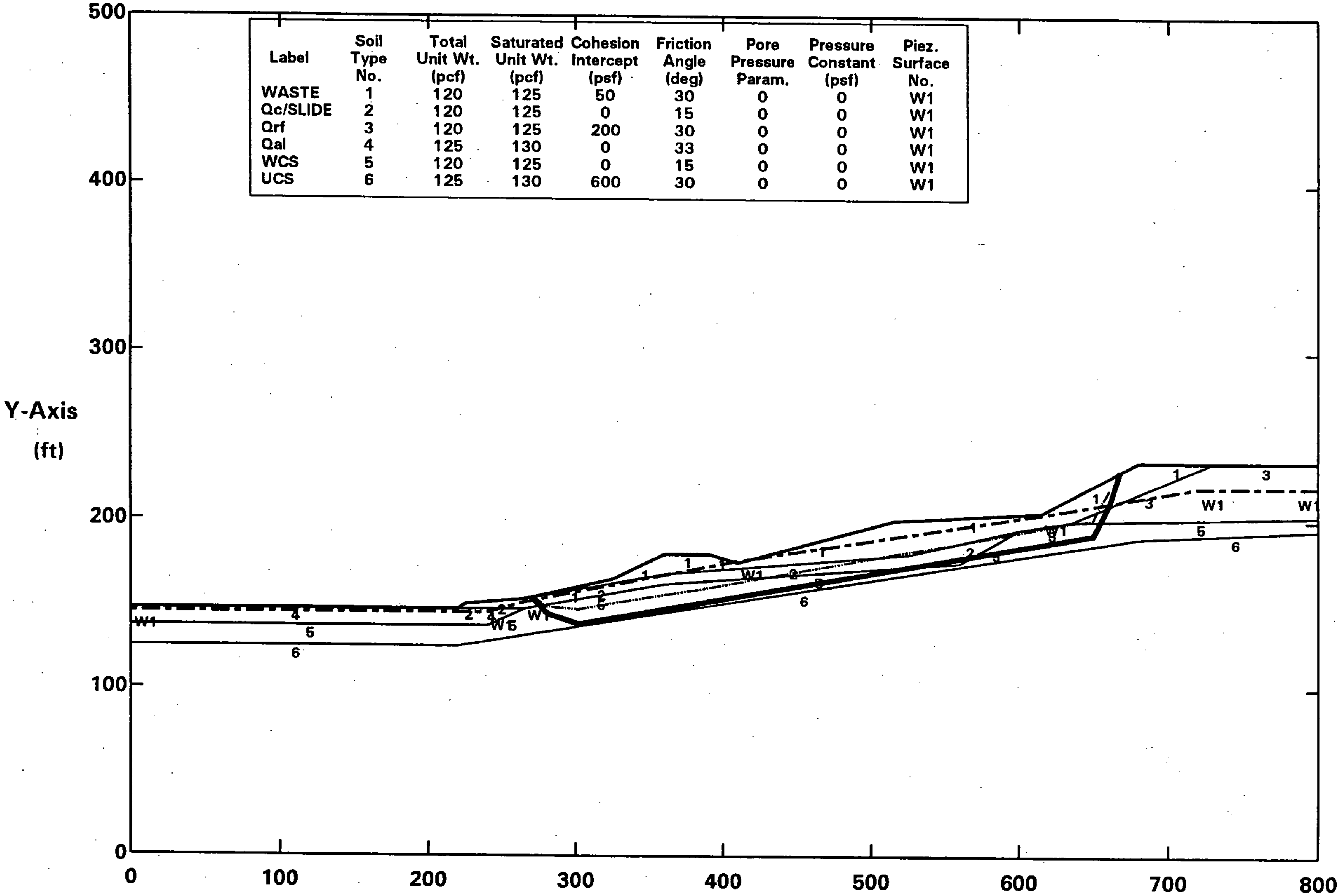
PCSTABL5M/SI FSmin = 1.02 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:BEAS06.PLT By: STAN KLINE 10-24-04 3:53am



Factors Of Safety Calculated By The Modified Janbu Method

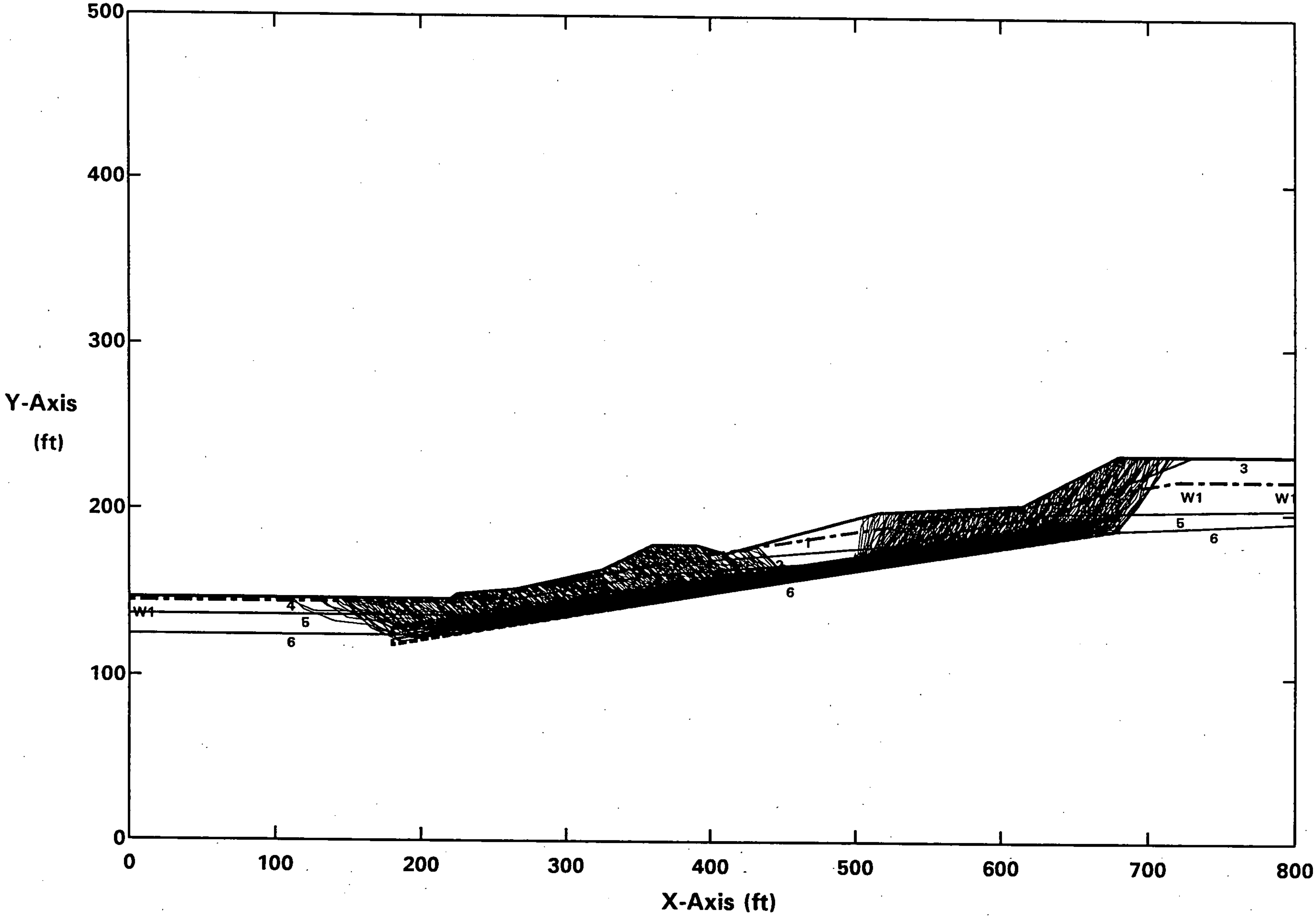
ROCKY FLATS OLF - M&E SECTION B - WCS=15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-BEAS06.OUT. C:BEAS06SP.PLT By: STAN KLINE 10-24-04 3:55am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

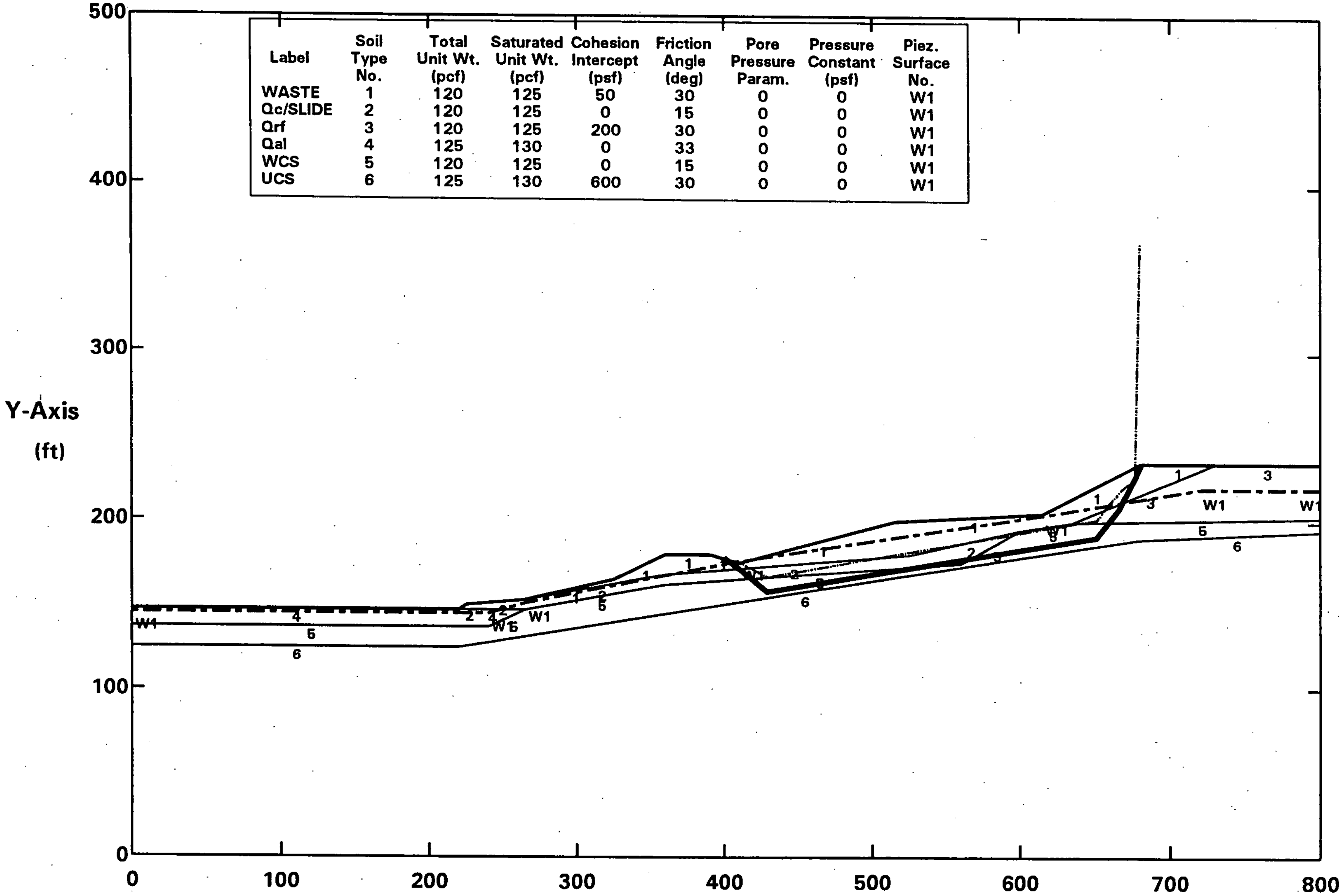
PCSTABL5M/SI FS=0.79 Theta=8.29 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.01g
All surfaces evaluated. C:BEAS01.PLT By: STAN KLINE 10-24-04 3:59am



Factors Of Safety Calculated By The Modified Janbu Method

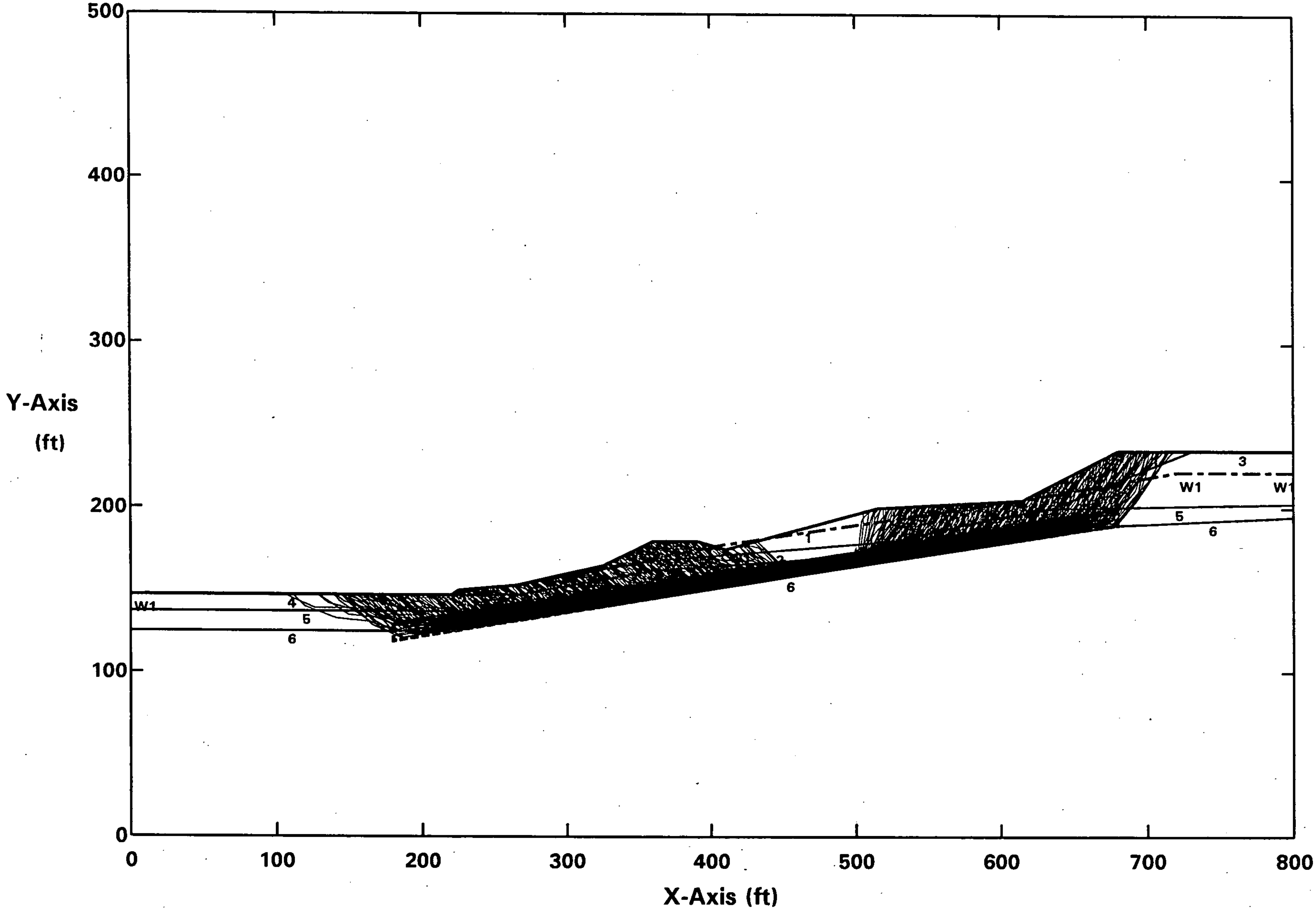
ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.01g
Surface #1-BEAS01.OUT. C:BEAS01SP.PLT By: STAN KLINE 10-24-04 4:00am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS = 1.04 Theta = 8.8 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

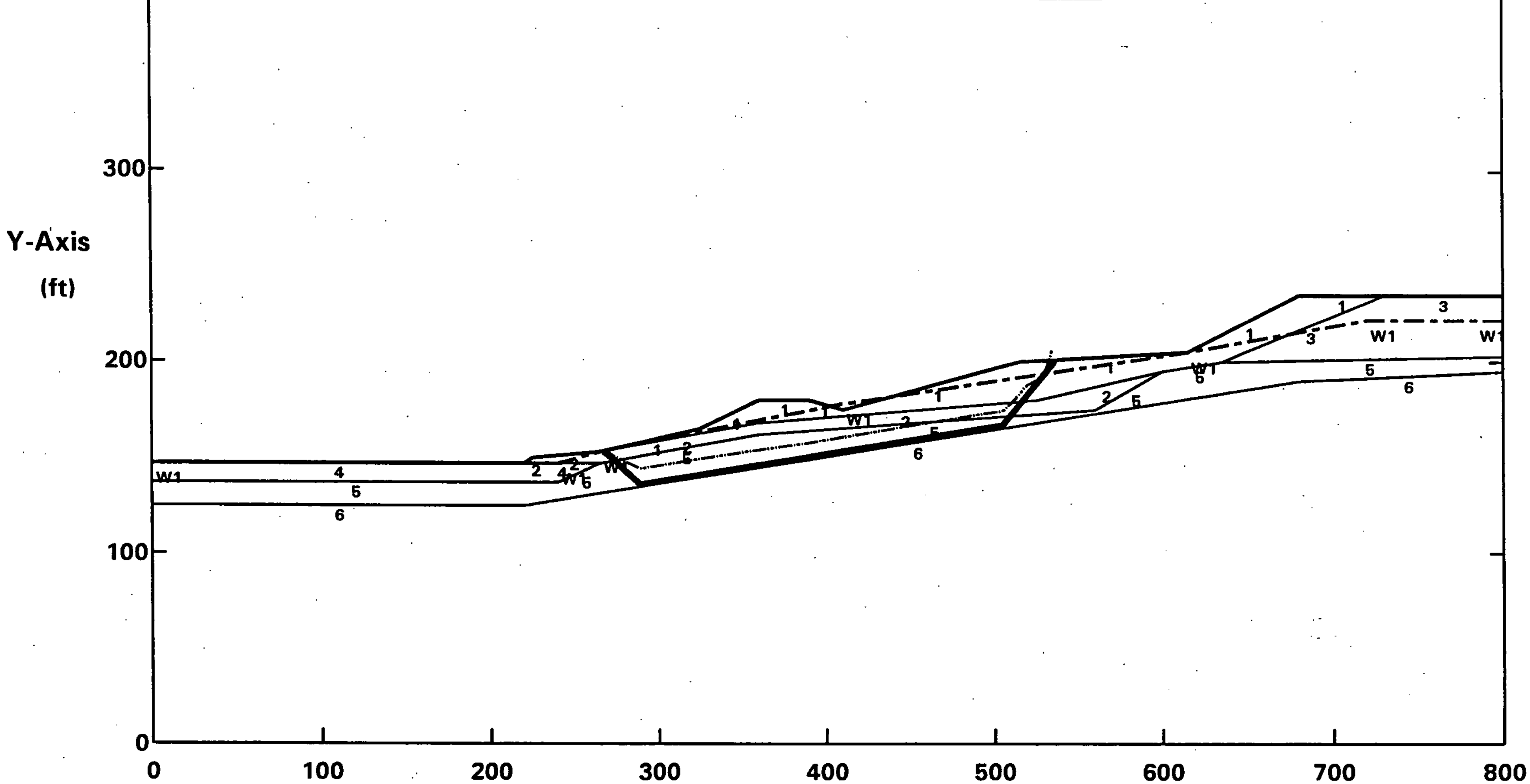
ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:BEHS06.PLT By: STAN KLINE 10-24-04 5:51pm



Factors Of Safety Calculated By The Modified Janbu Method

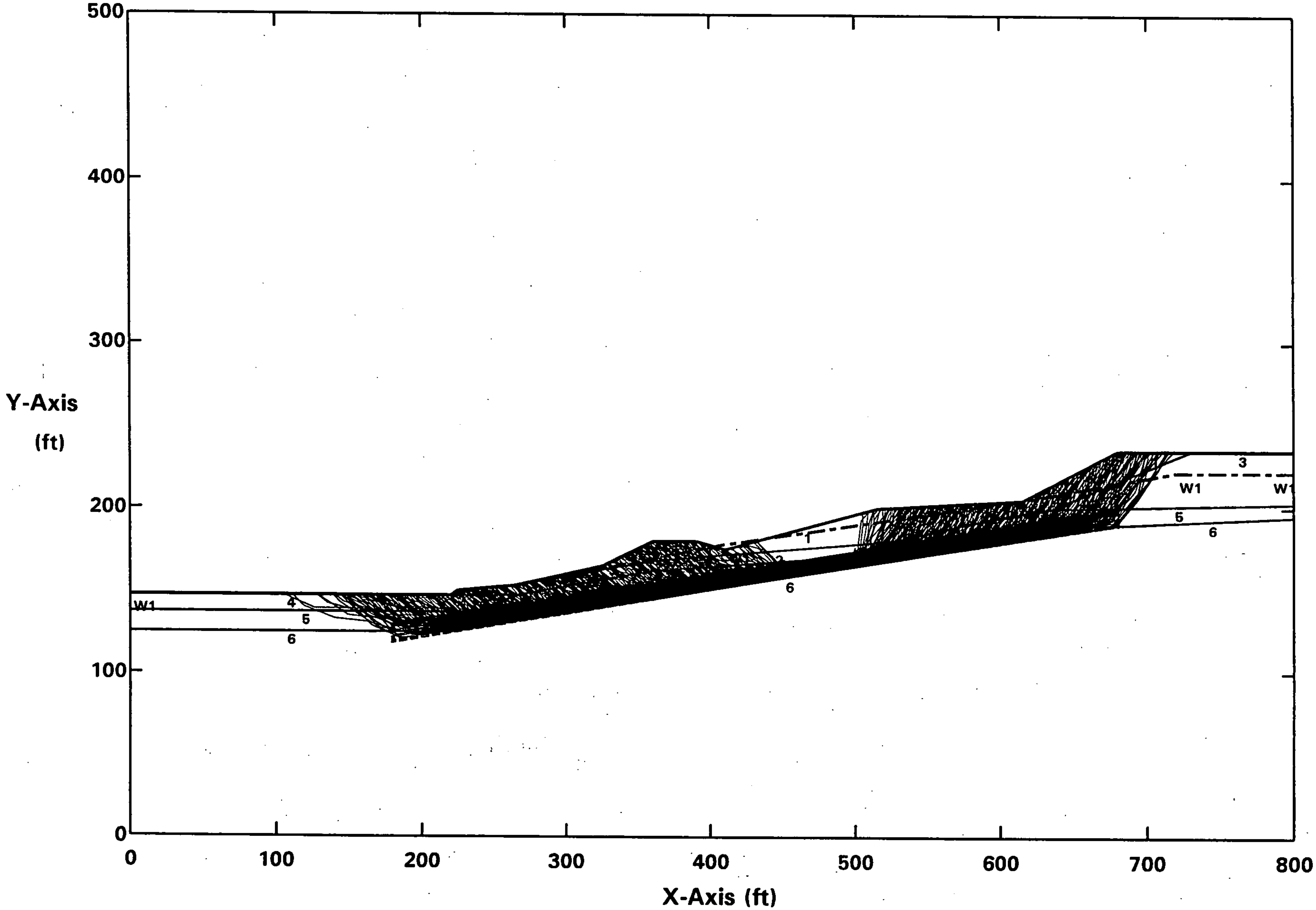
ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-BEHS06.OUT. C:BEHS06SP.PLT By: STAN KLINE 10-24-04 5:54pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



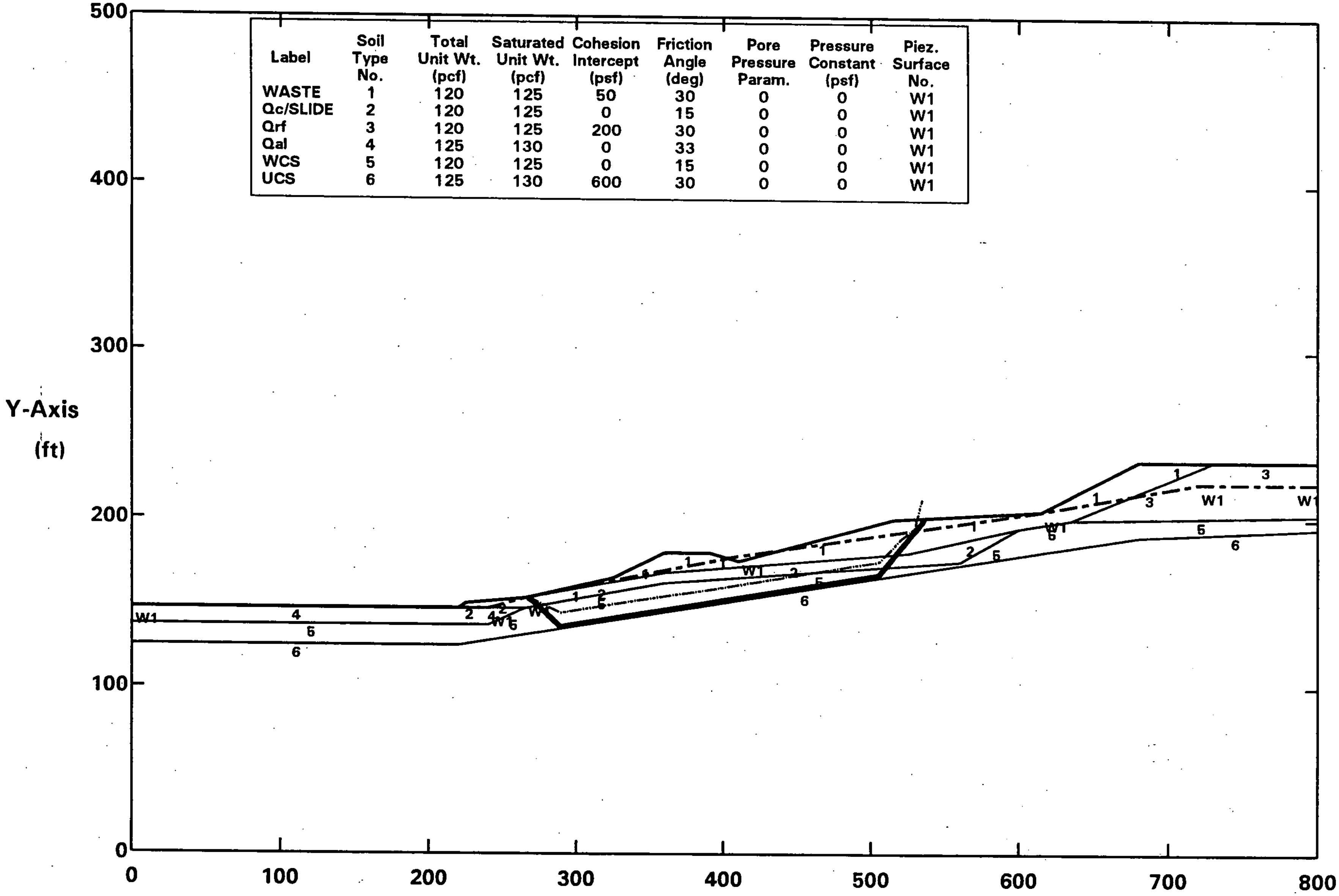
PCSTABL5M/SI FS = 0.76 Theta = 7.76 X-Axis (ft)
Factors Of Safety Calculated By Spencer's Method of Slices

ROCKY FLATS OLF - M&E SECTION B - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.009g
All surfaces evaluated. C:BEHS01.PLT By: STAN KLINE 10-26-04 12:51am



Factors Of Safety Calculated By The Modified Janbu Method

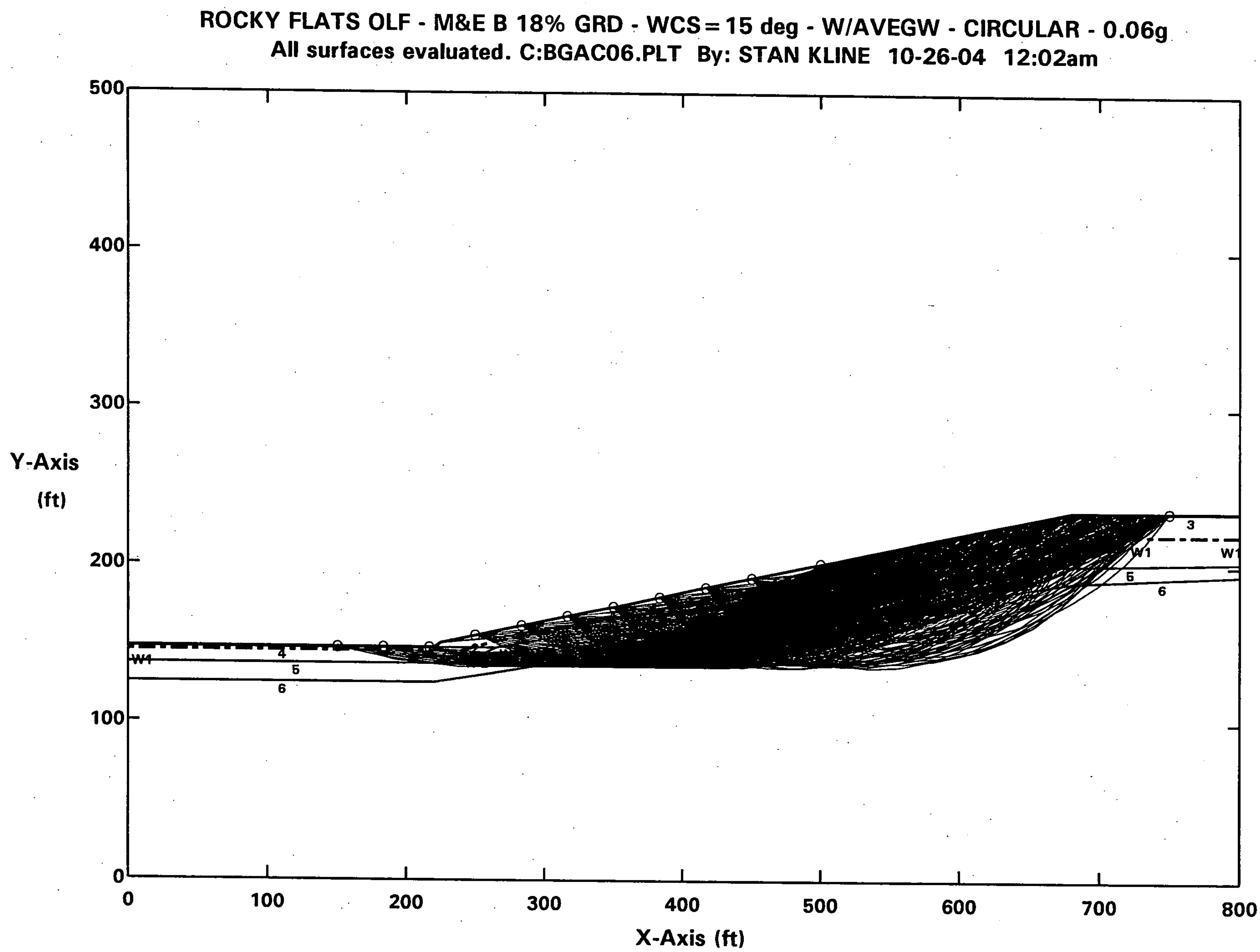
ROCKY FLATS OLF - M&E SECTION B - WCS=15 deg - W/HIGHGW - SLIDING BLOCK - 0.009g
Surface #1-BEHS01.OUT. C:BEHS01SP.PLT By: STAN KLINE 10-26-04 12:51am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

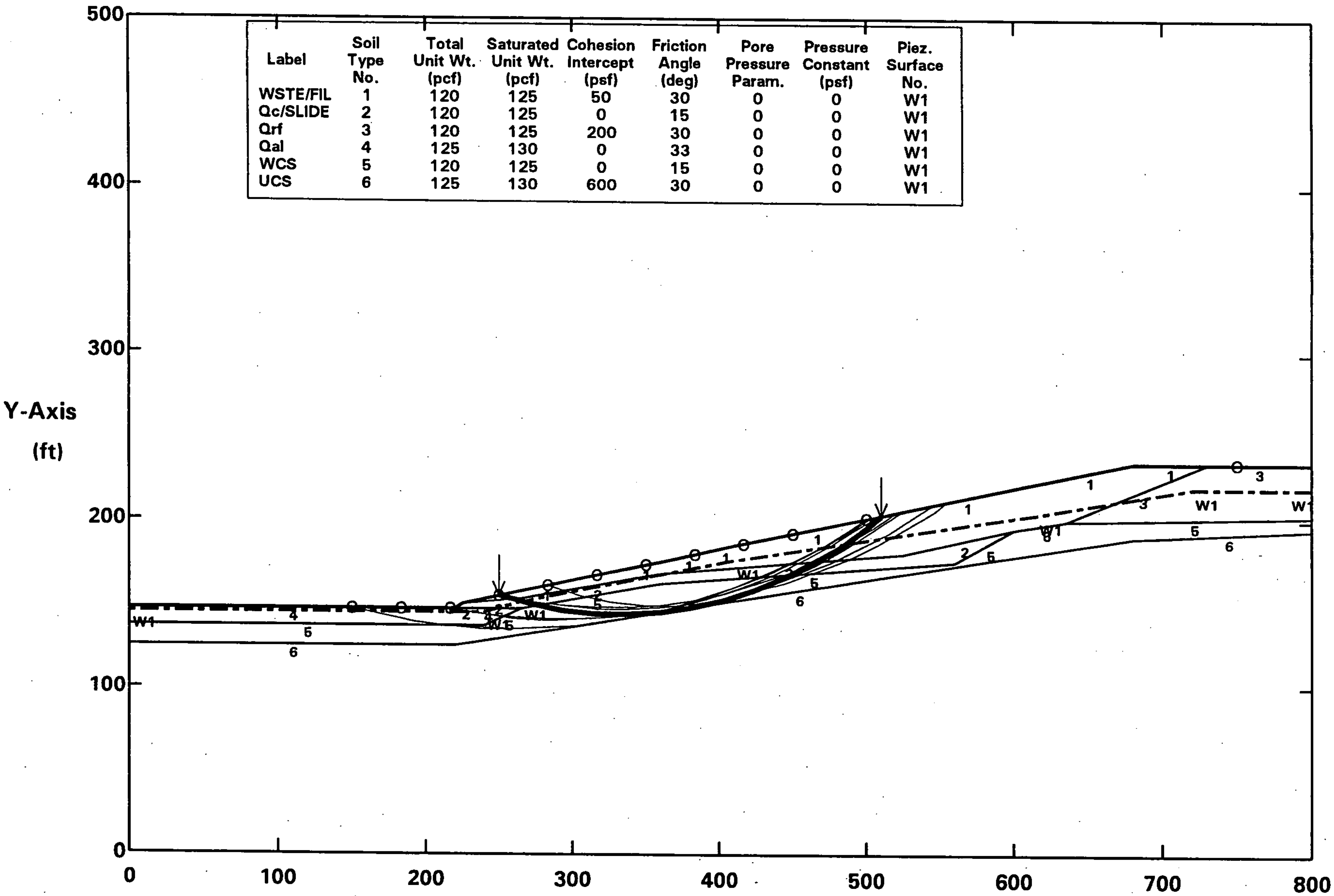
PCSTABL5M/SI FS=1.00 Theta=8.1 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

18% REGRADE CONDITION



Factors Of Safety Calculated By The Modified Bishop Method

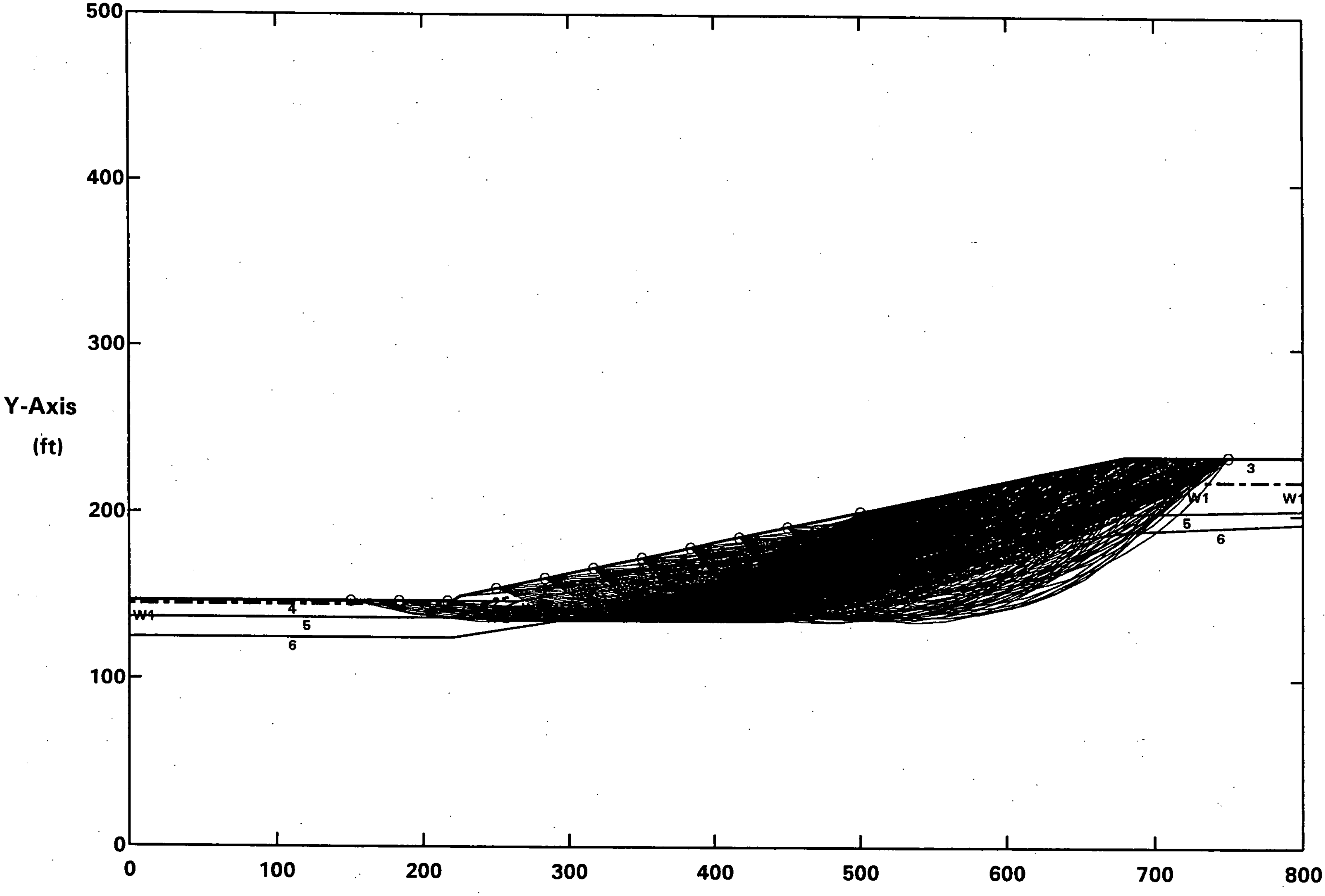
ROCKY FLATS OLF - M&E B 18% GRD - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:BGAC06.PLT By: STAN KLINE 10-26-04 12:02am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

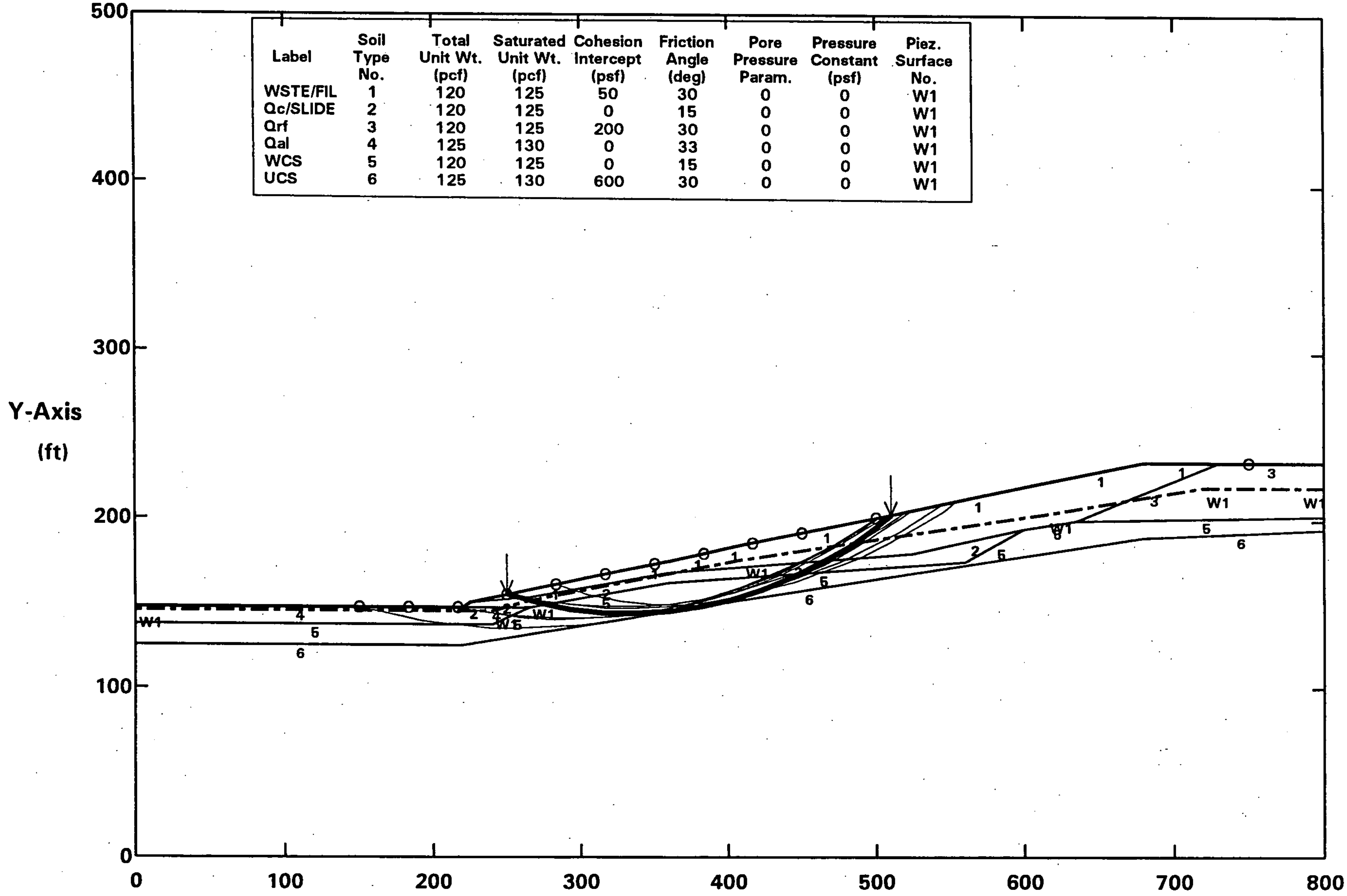
PCSTABL5M/SI FSmin = 0.90 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18% GRD - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.03g
All surfaces evaluated. C:BGAC03.PLT By: STAN KLINE 10-26-04 12:01am



Factors Of Safety Calculated By The Modified Bishop Method

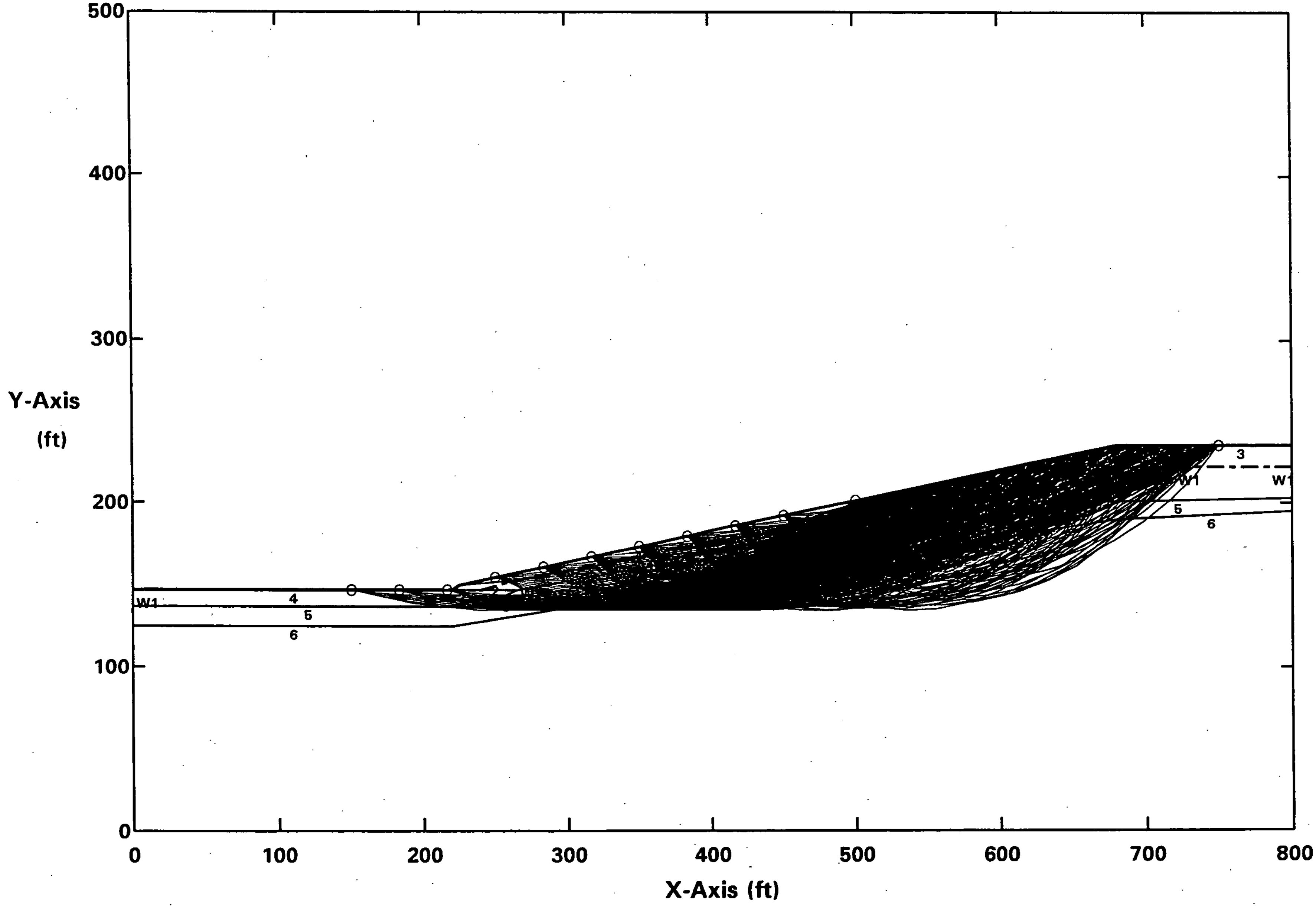
ROCKY FLATS OLF - M&E B 18% GRD - WCS=15 deg - W/AVEGW - CIRCULAR - 0.03g
Ten Most Critical. C:BGAC03.PLT By: STAN KLINE 10-26-04 12:01am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

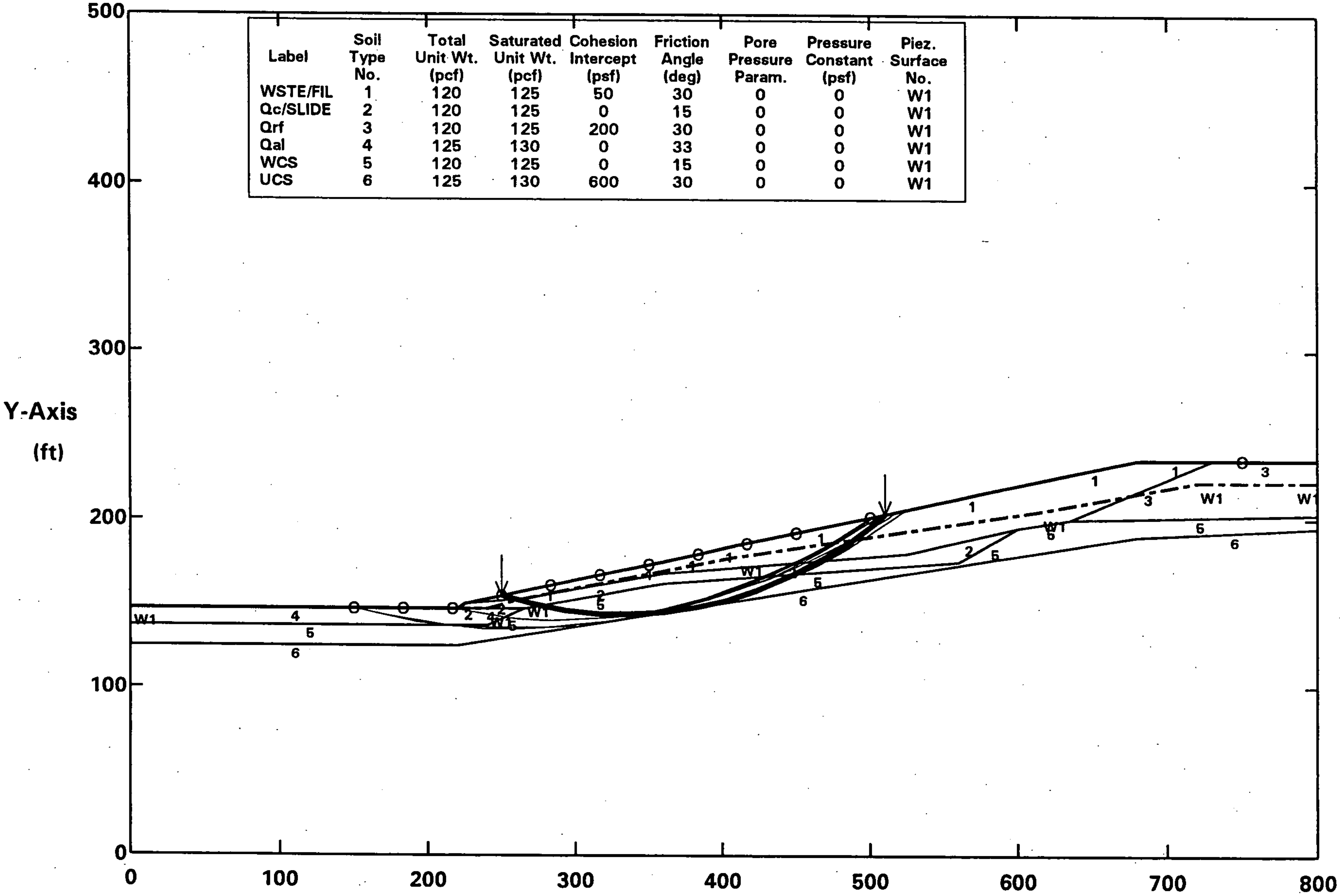
PCSTABL5M/SI FSmin=1.04 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18% GRD - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.06g
All surfaces evaluated. C:BGHC06.PLT By: STAN KLINE 10-26-04 12:07am



Factors Of Safety Calculated By The Modified Bishop Method

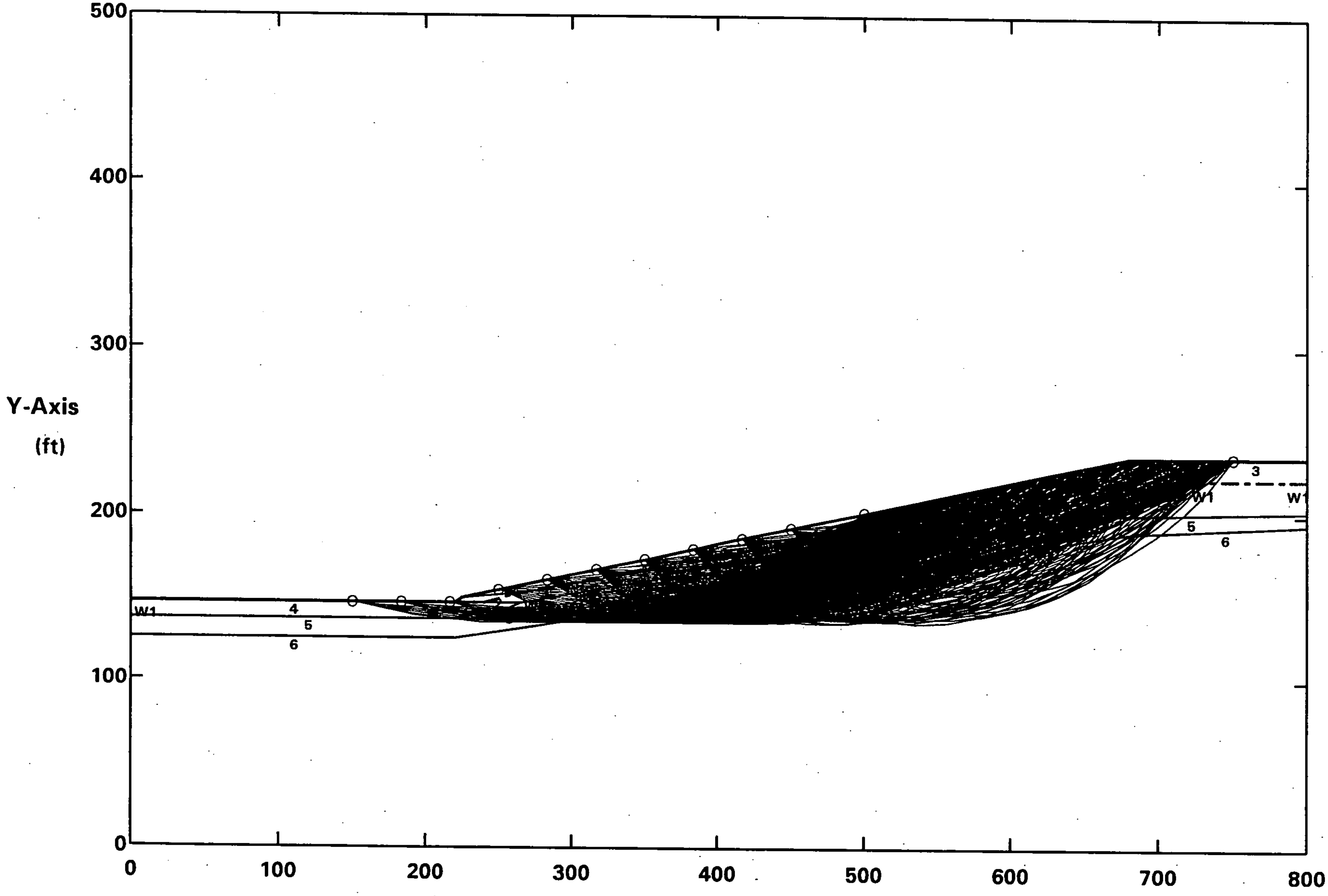
ROCKY FLATS OLF - M&E B 18% GRD - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:BGHC06.PLT By: STAN KLINE 10-26-04 12:07am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

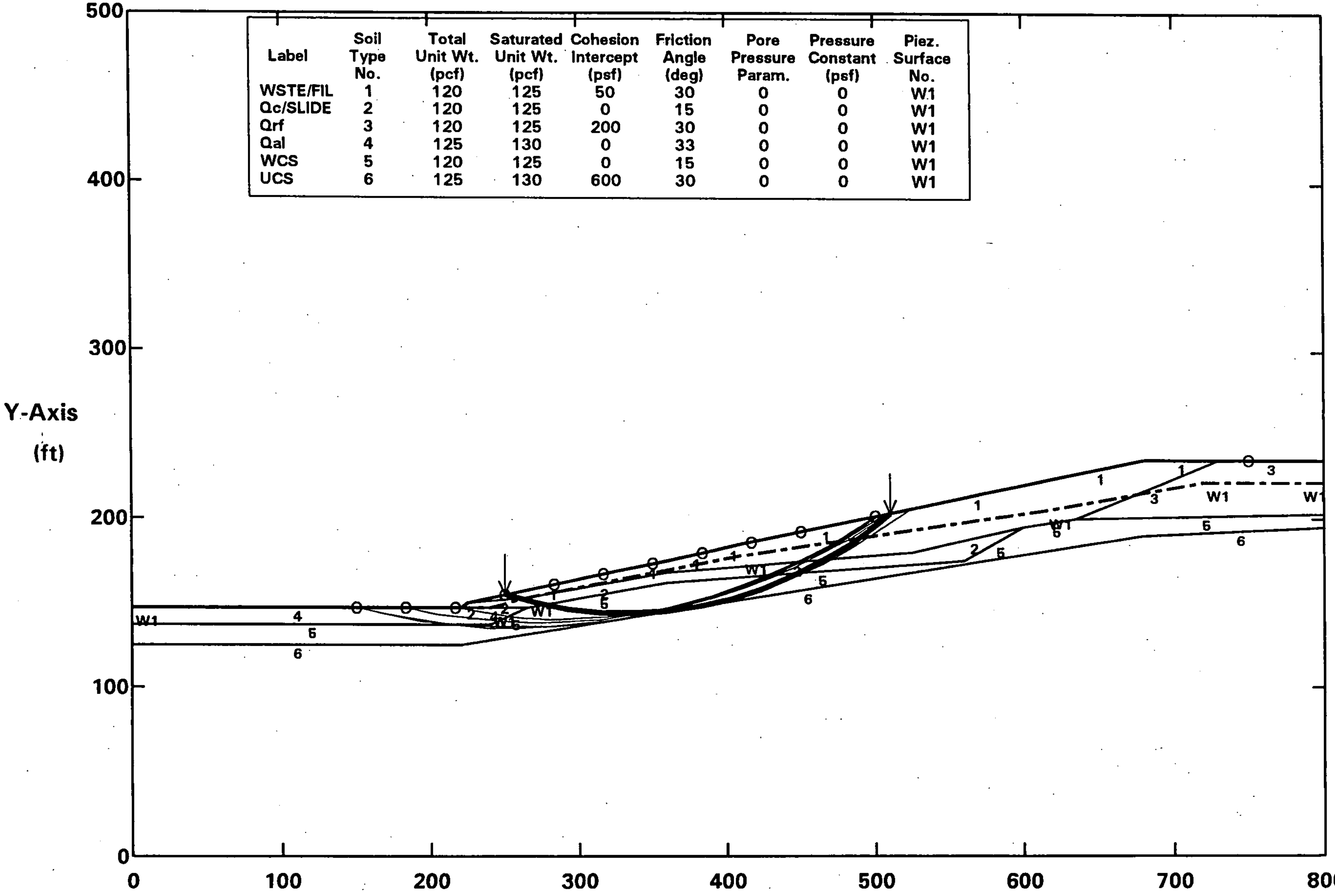
PCSTABL5M/SI FSmin=0.85 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18% GRD - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.02g
All surfaces evaluated. C:BGHC02.PLT By: STAN KLINE 10-26-04 12:06am



Factors Of Safety Calculated By The Modified Bishop Method

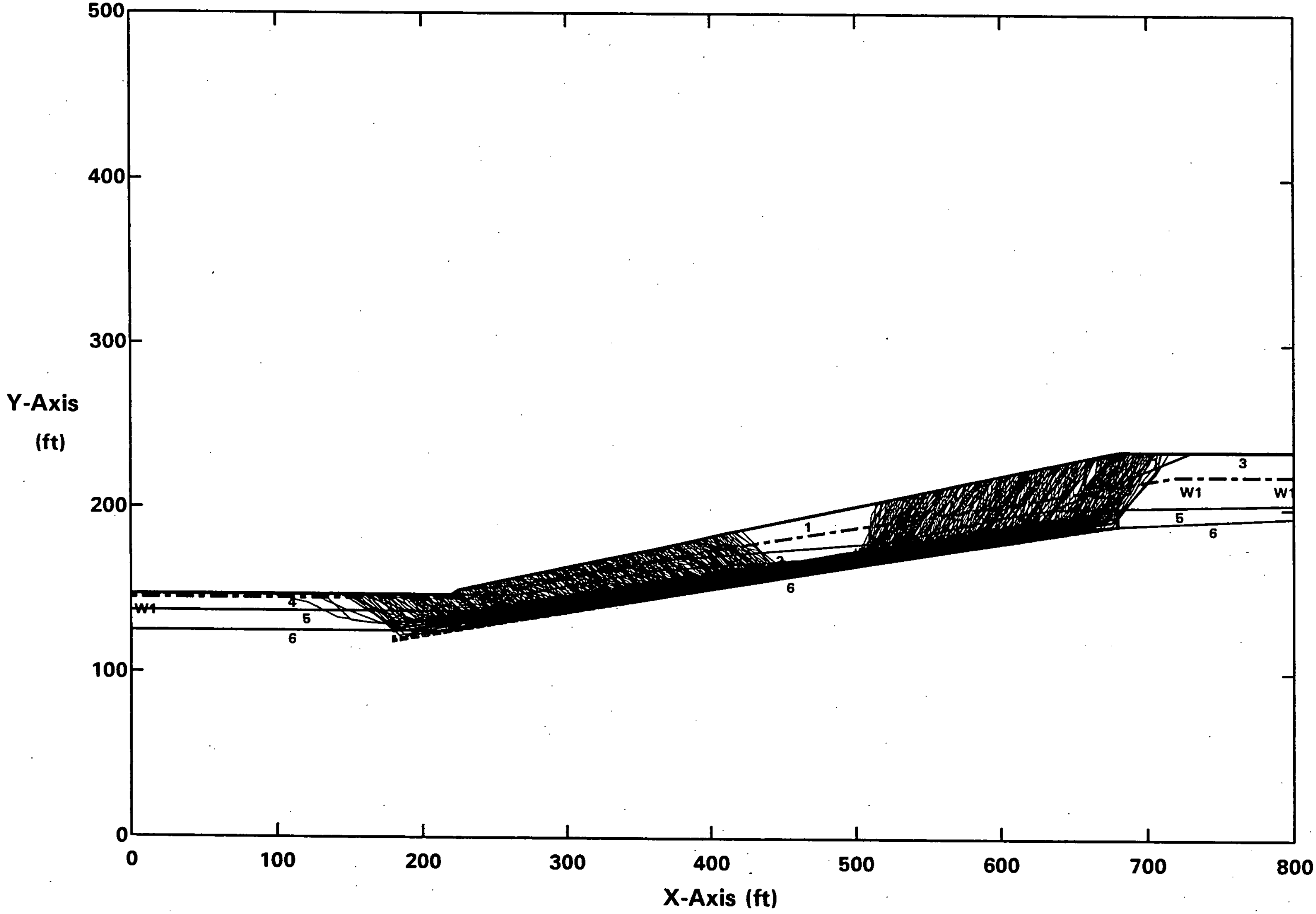
ROCKY FLATS OLF - M&E B 18% GRD - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.02g
Ten Most Critical. C:BGHC02.PLT By: STAN KLINE 10-26-04 12:06am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin=1.03 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

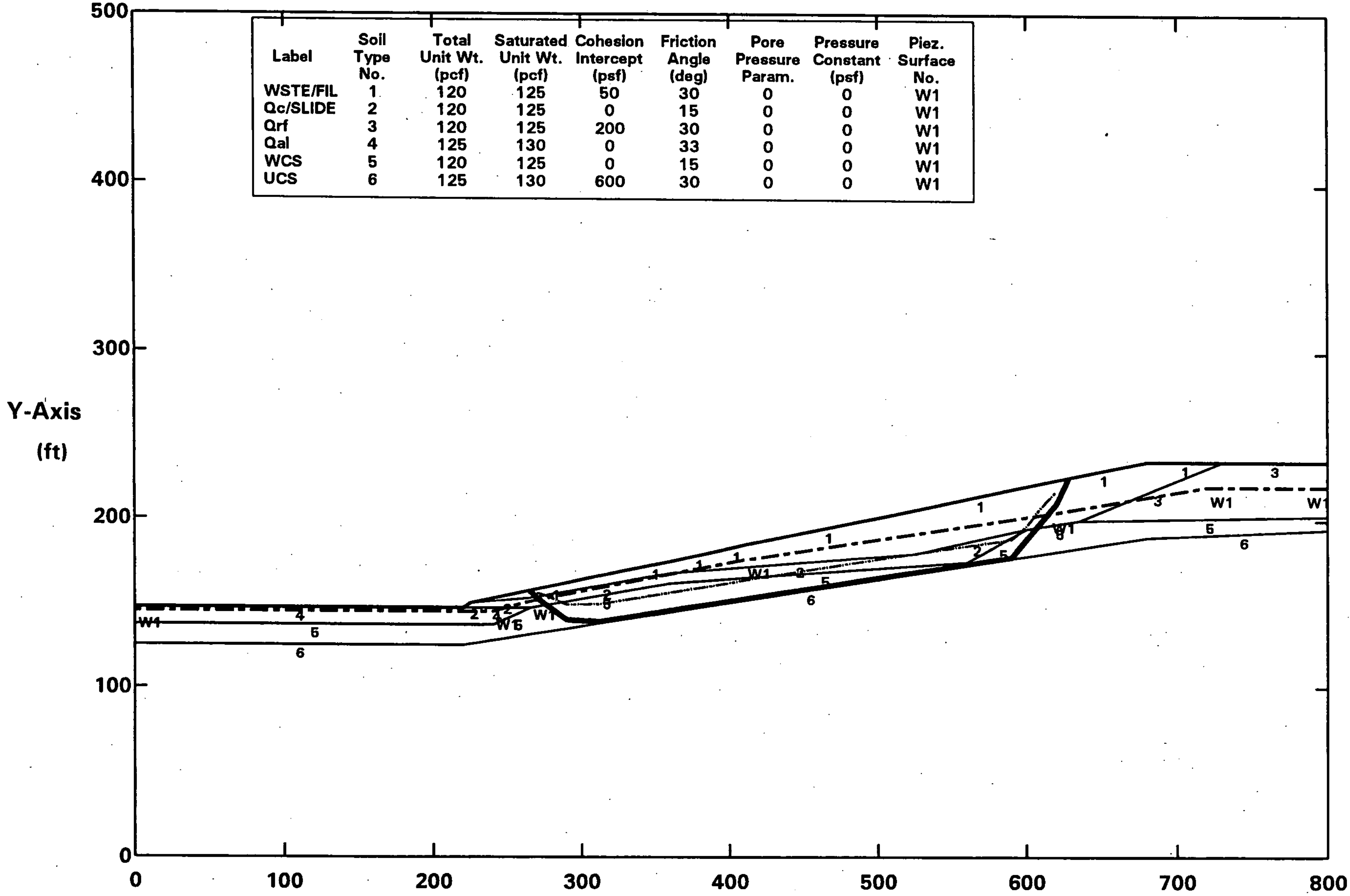
ROCKY FLATS OLF - M&E B 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:BGAS06.PLT By: STAN KLINE 10-26-04 12:45am



Factors Of Safety Calculated By The Modified Janbu Method

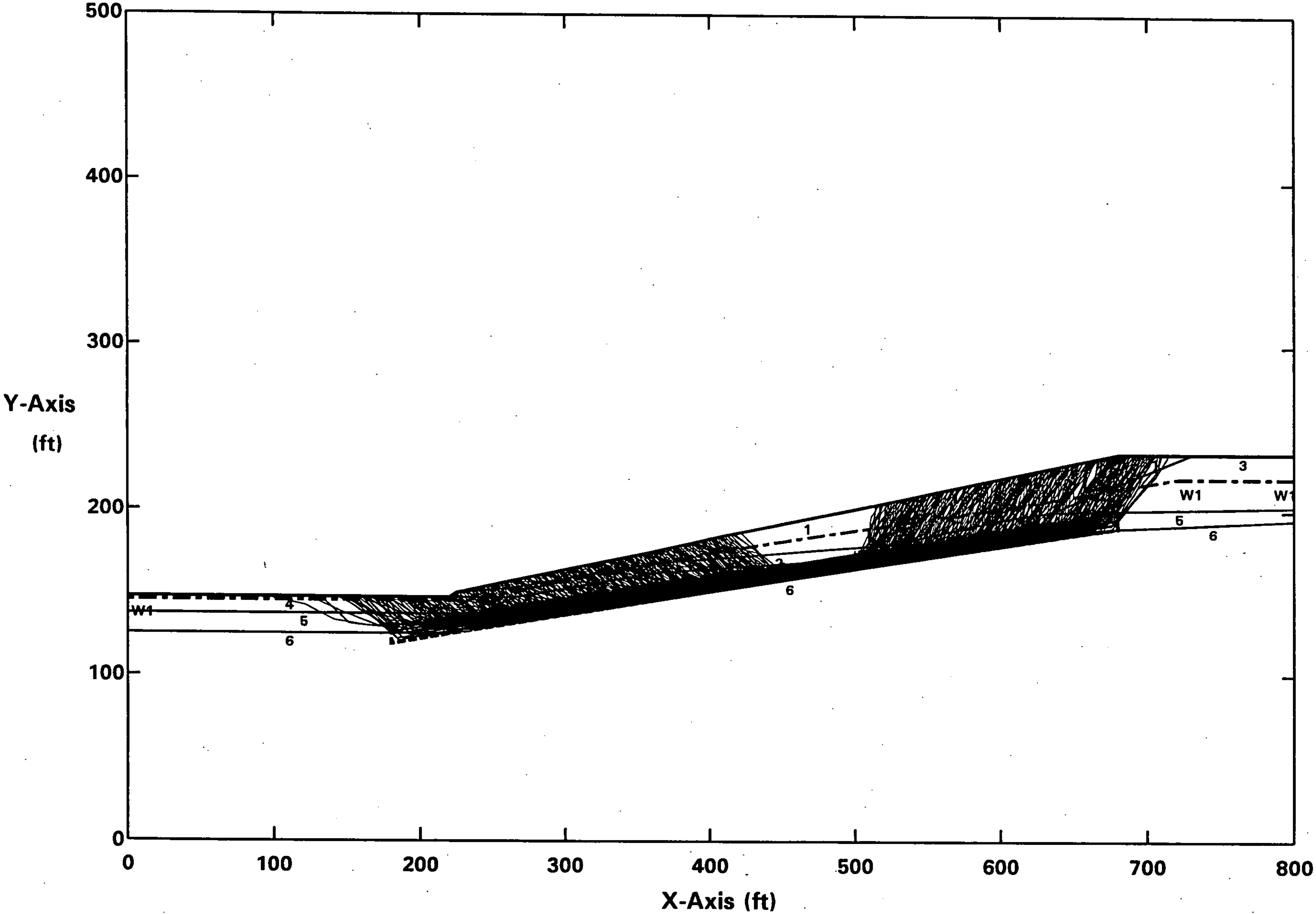
ROCKY FLATS OLF - M&E B 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-BGAS06.OUT. C:BGAS06SP.PLT By: STAN KLINE 10-26-04 12:46am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS = 0.88 Theta = 7.96 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

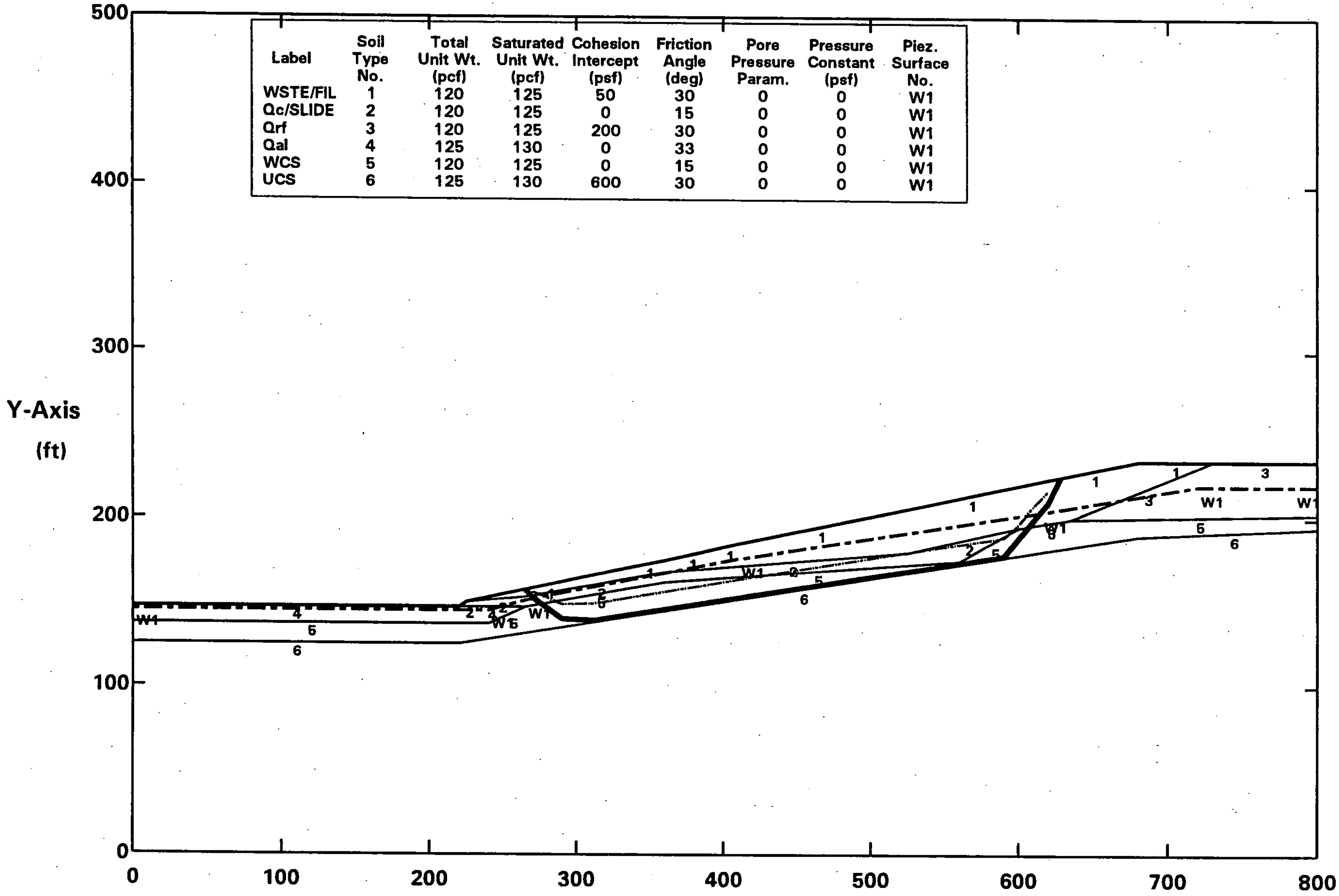
ROCKY FLATS OLF - M&E B 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.03g
All surfaces evaluated. C:BGAS03.PLT By: STAN KLINE 10-26-04 12:43am



Factors Of Safety Calculated By The Modified Janbu Method

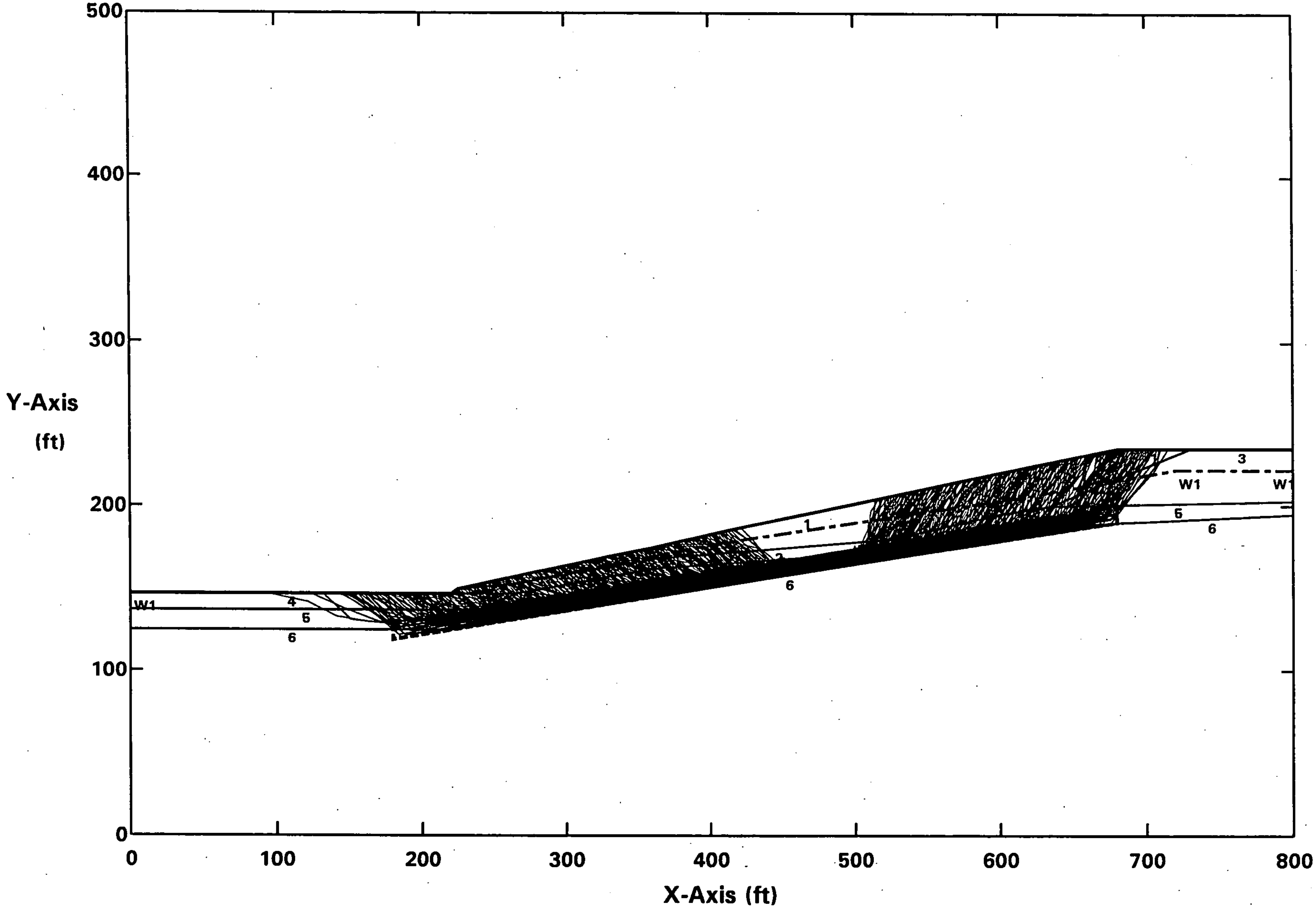
ROCKY FLATS OLF - M&E B 18% GRD - WCS=15 deg - W/AVEGW - SLIDING BLOCK - 0.03g
Surface #1-BGAS03.OUT. C:BGAS03SP.PLT By: STAN KLINE 10-26-04 12:44am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS=1.02 Theta=8.26 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

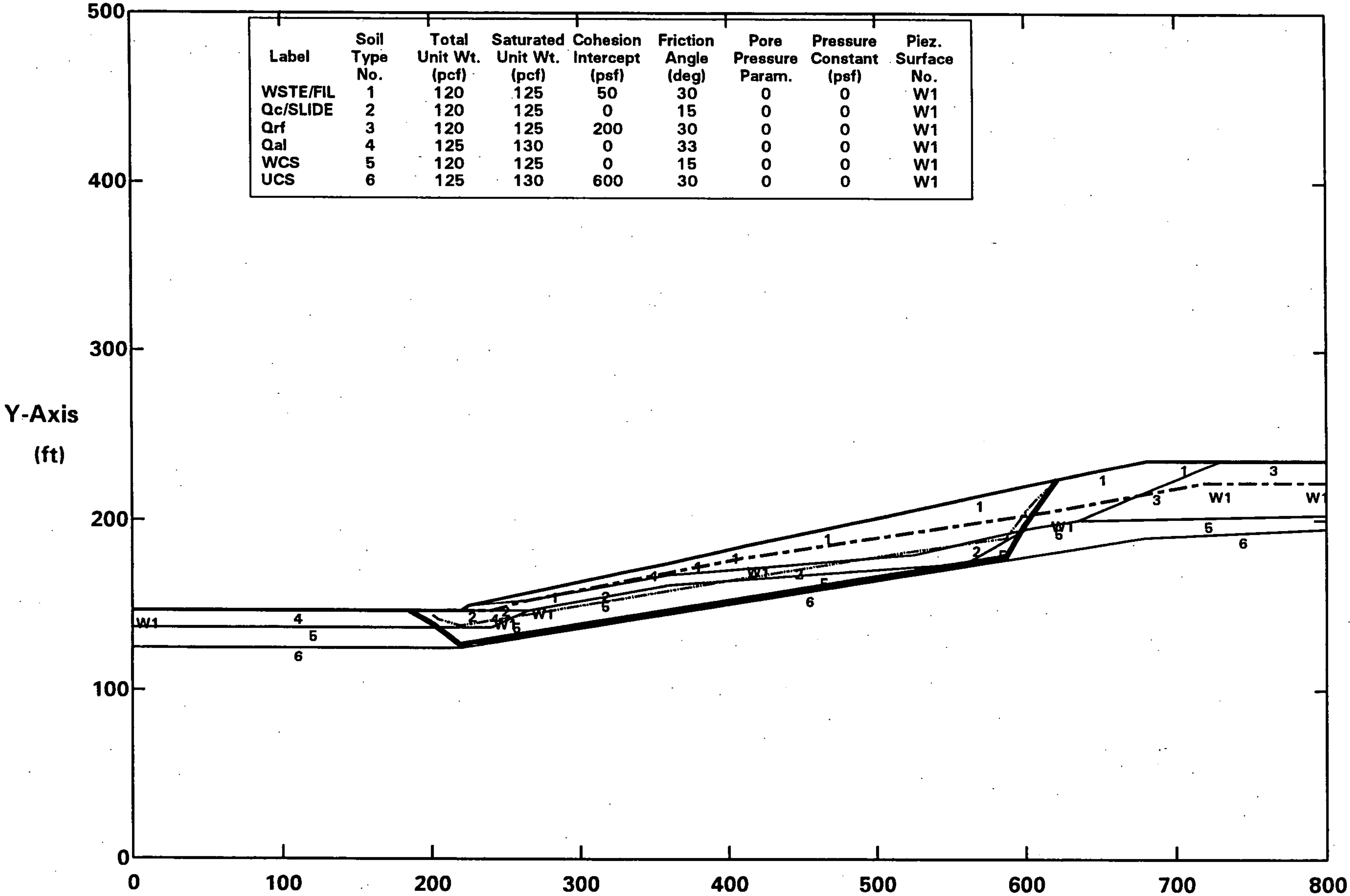
ROCKY FLATS OLF - M&E B 18% GRD - WCS= 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:BGHS06.PLT By: STAN KLINE 10-24-04 6:05pm



Factors Of Safety Calculated By The Modified Janbu Method

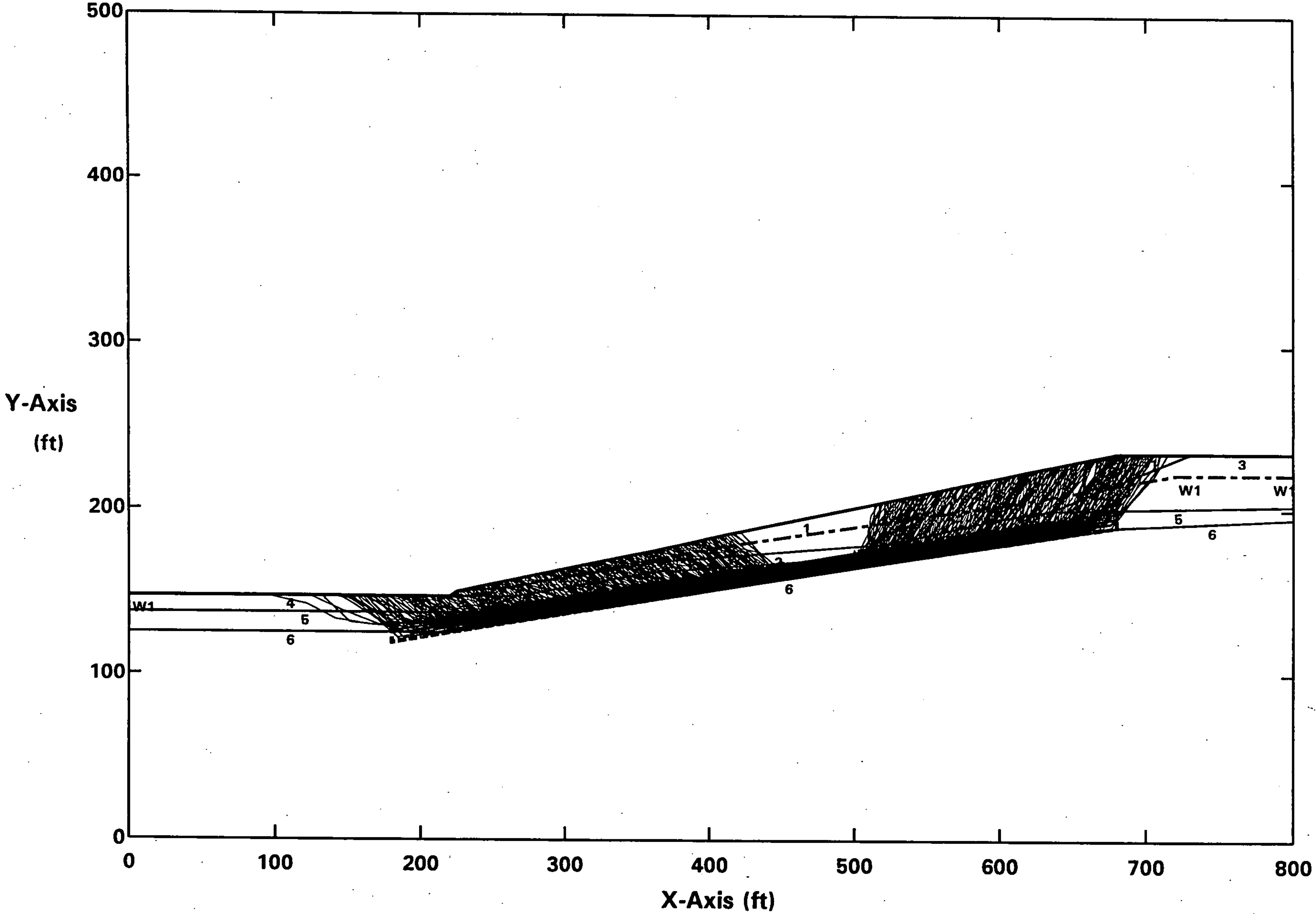
ROCKY FLATS OLF - M&E B 18% GRD - WCS= 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-BGHS06.OUT. C:BGHS06SP.PLT By: STAN KLINE 10-24-04 6:07pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS=0.85 Theta=7.86 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

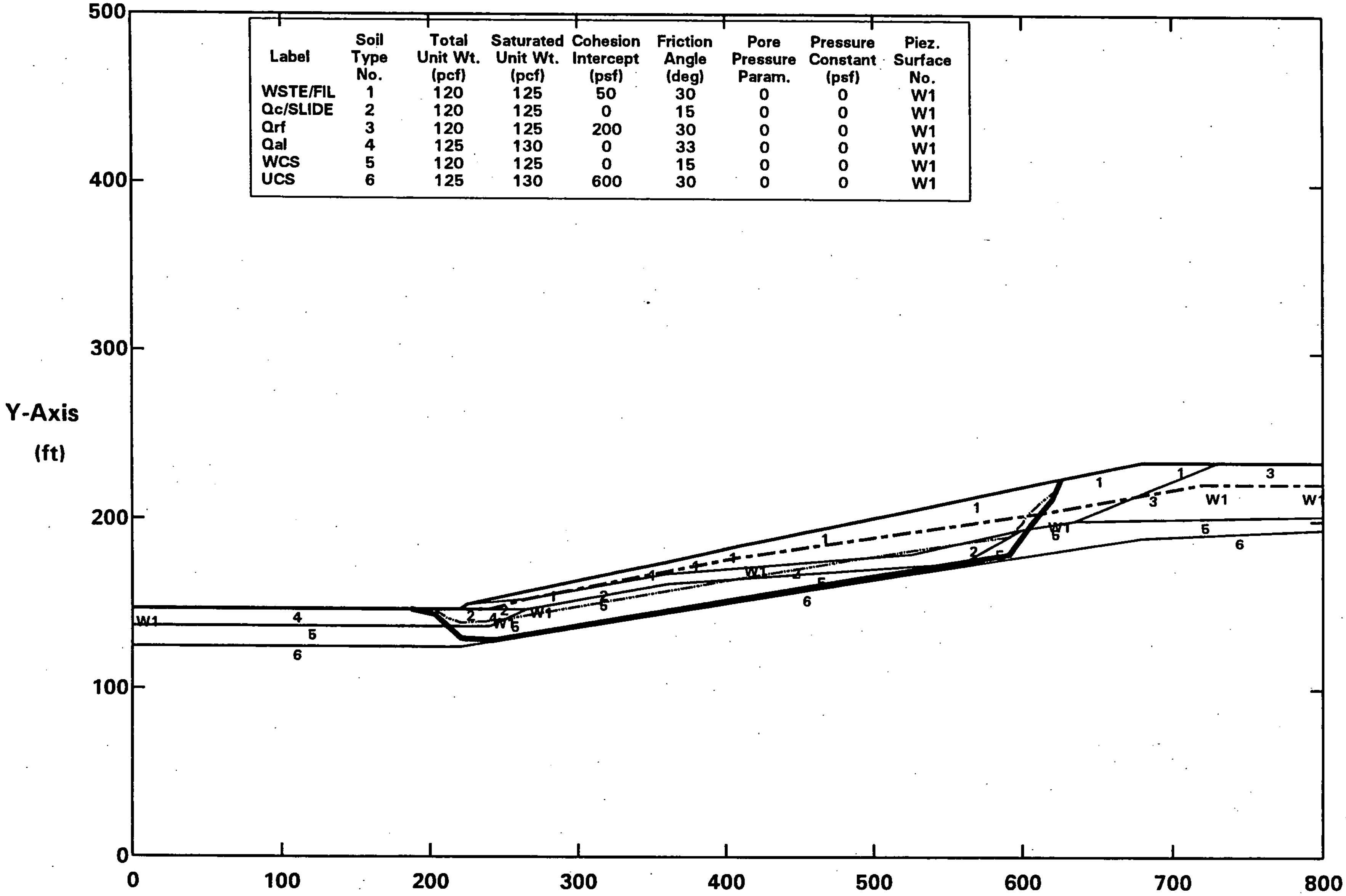
ROCKY FLATS OLF - M&E B 18% GRD - WCS= 15 deg - W/HIGHGW - SLIDING BLOCK - 0.02g
All surfaces evaluated. C:BGHS02.PLT By: STAN KLINE 10-24-04 6:02pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E B 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.02g
Surface #1-BGHS02.OUT. C:BGHS02SP.PLT By: STAN KLINE 10-24-04 6:04pm

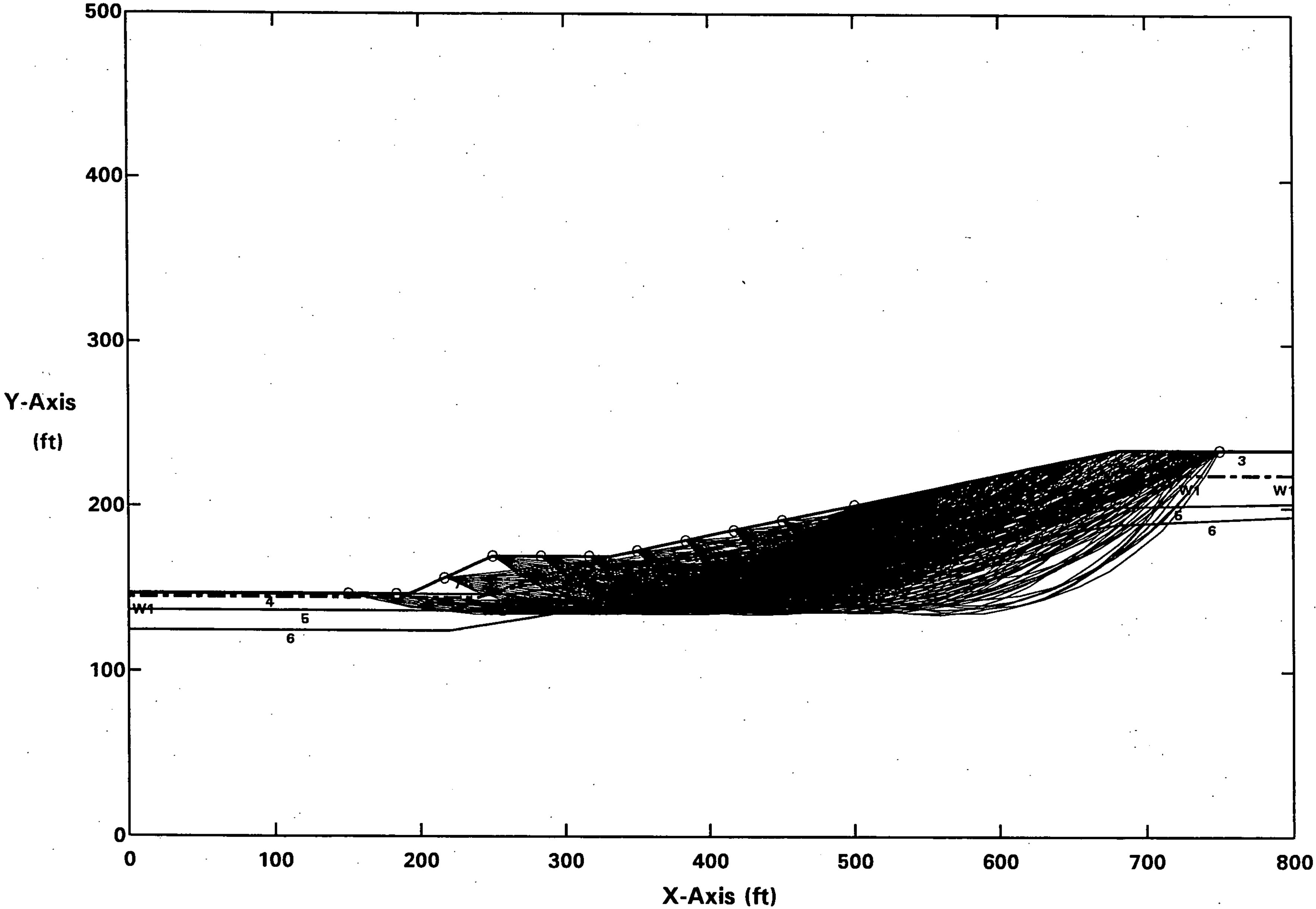
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS = 1.03 Theta = 8.19 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

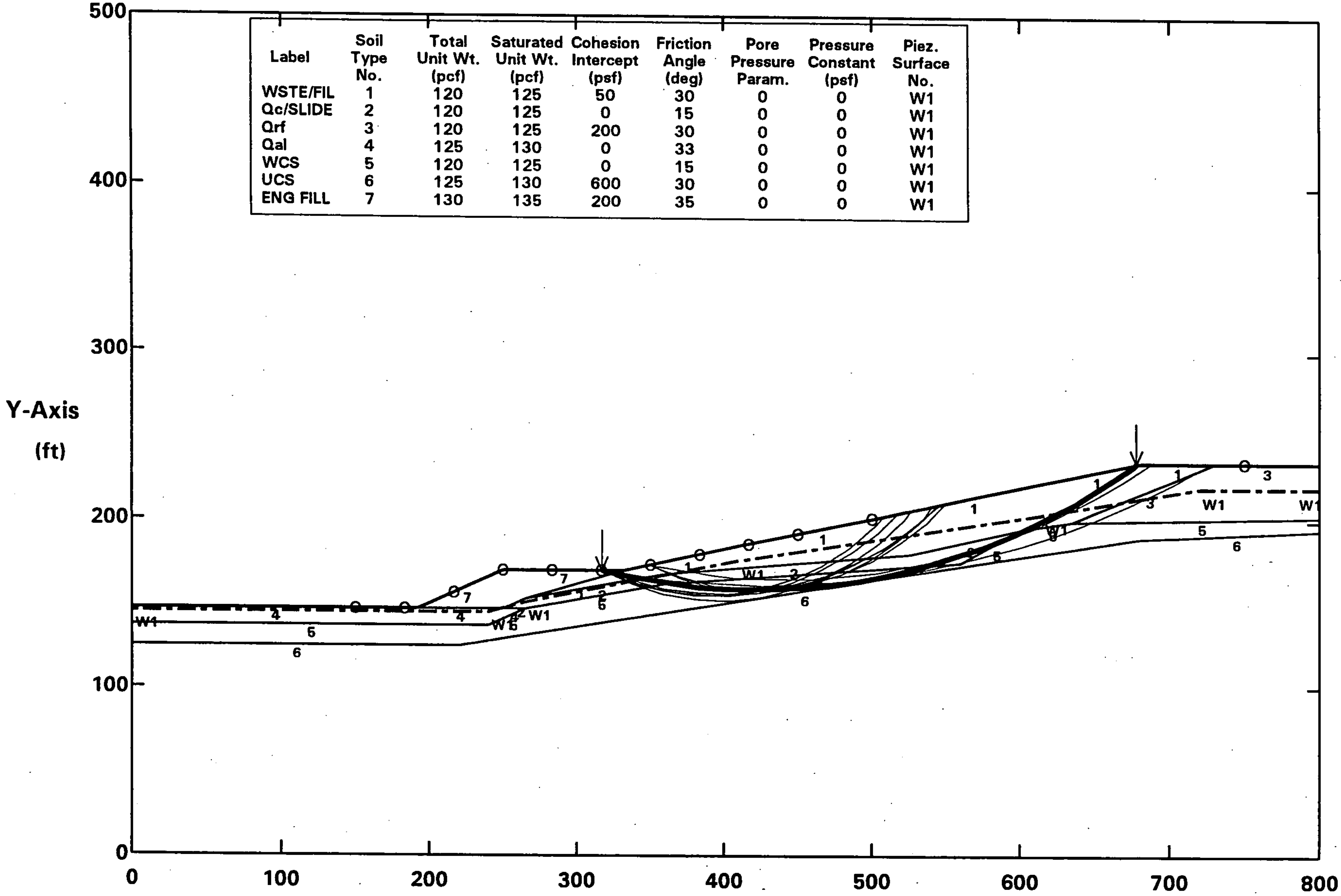
18% REGRADE WITH BUTTRESS CONDITION

ROCKY FLATS OLF - M&E B 18%W/BM - WCS= 15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:BBAC06.PLT By: STAN KLINE 10-26-04 12:03am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:BBAC06.PLT By: STAN KLINE 10-26-04 12:03am

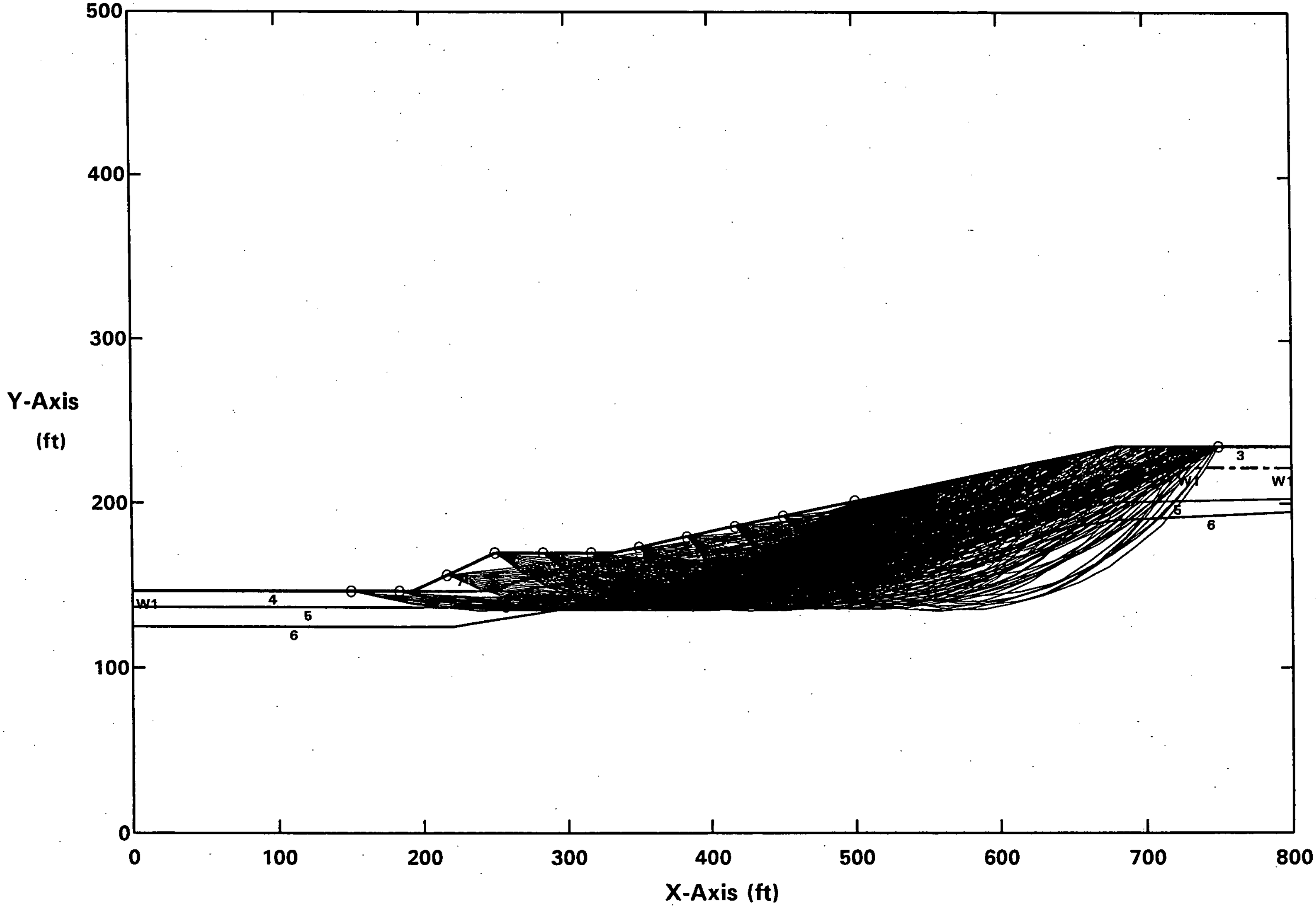


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FSmin = 1.01 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.06g

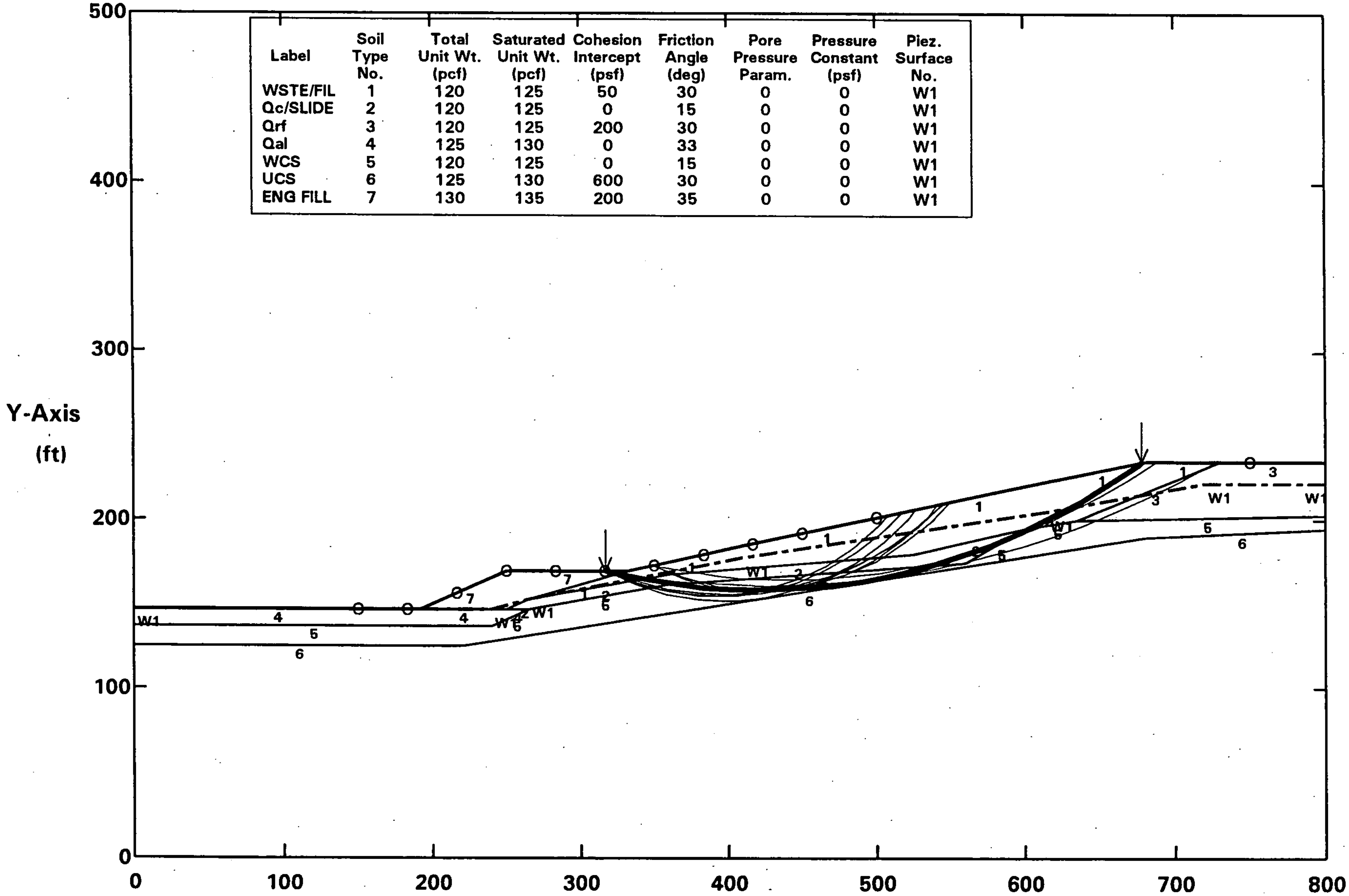
All surfaces evaluated. C:BBHC06.PLT By: STAN KLINE 10-26-04 12:09am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.06g

Ten Most Critical. C:BBHC06.PLT By: STAN KLINE 10-26-04 12:09am

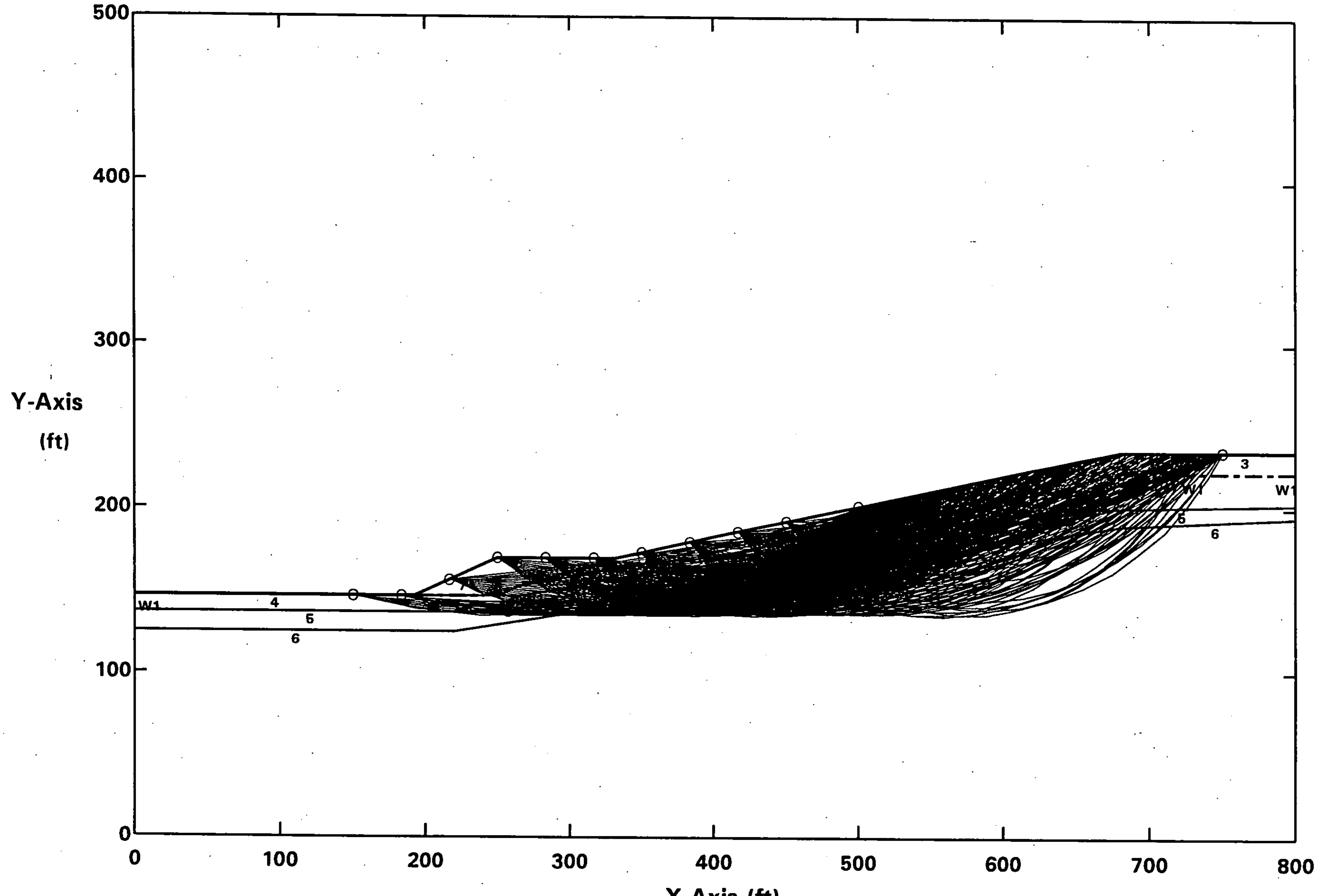


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FSmin=0.98 X-Axis (ft)

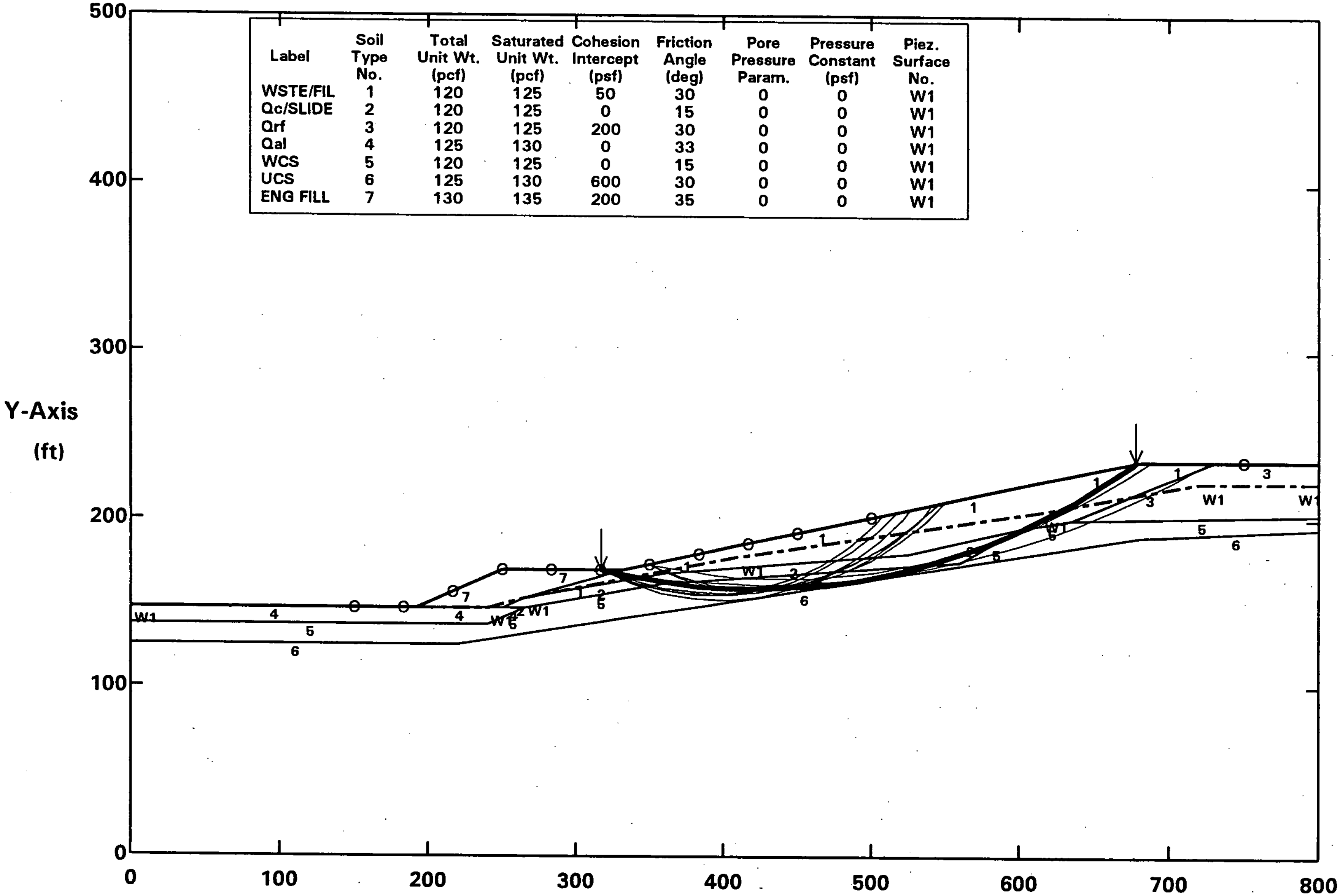
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.05g
All surfaces evaluated. C:BBHC05.PLT By: STAN KLINE 10-26-04 12:07am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.05g
Ten Most Critical. C:BBHC05.PLT By: STAN KLINE 10-26-04 12:07am

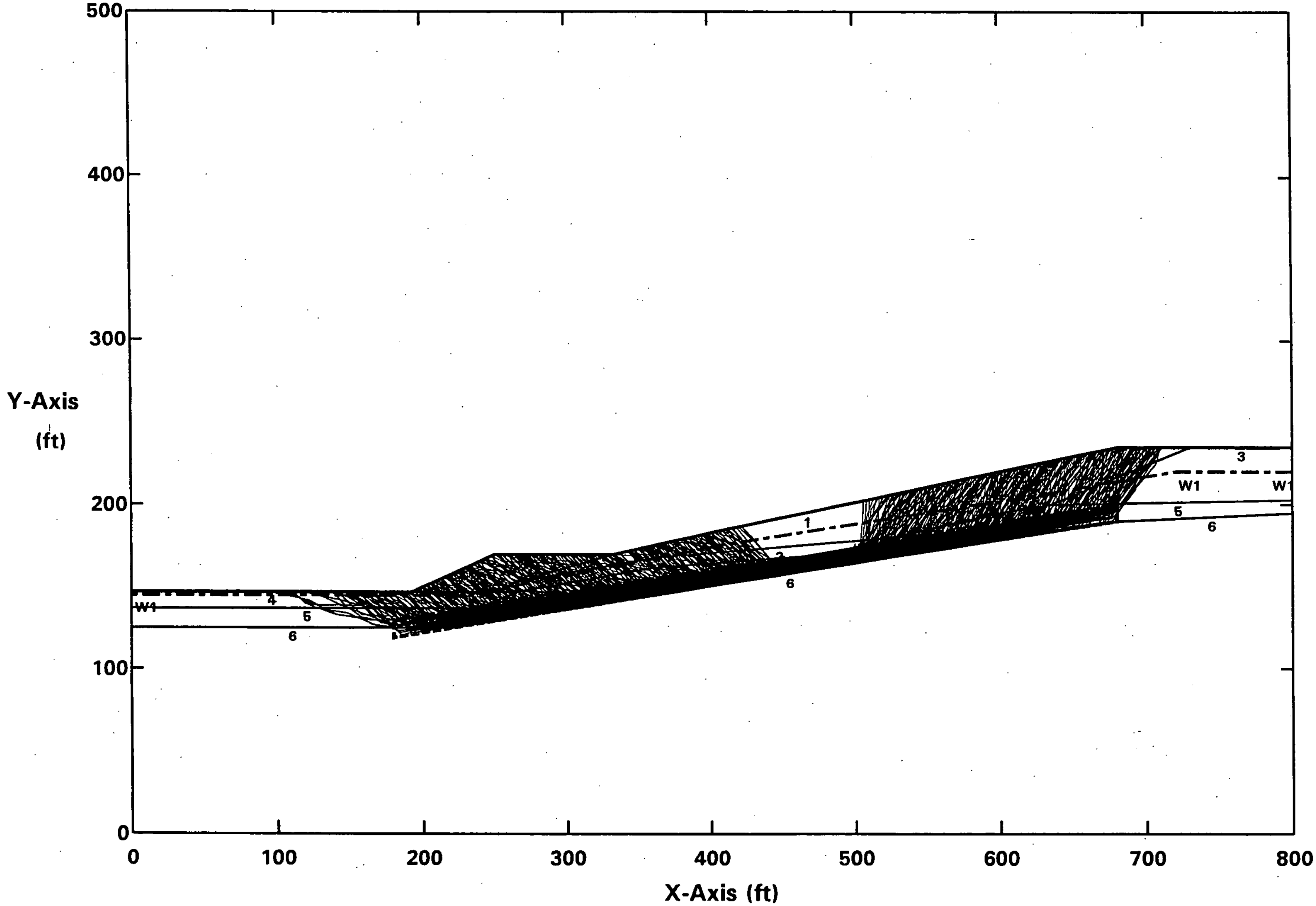


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FSmin = 1.02 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g

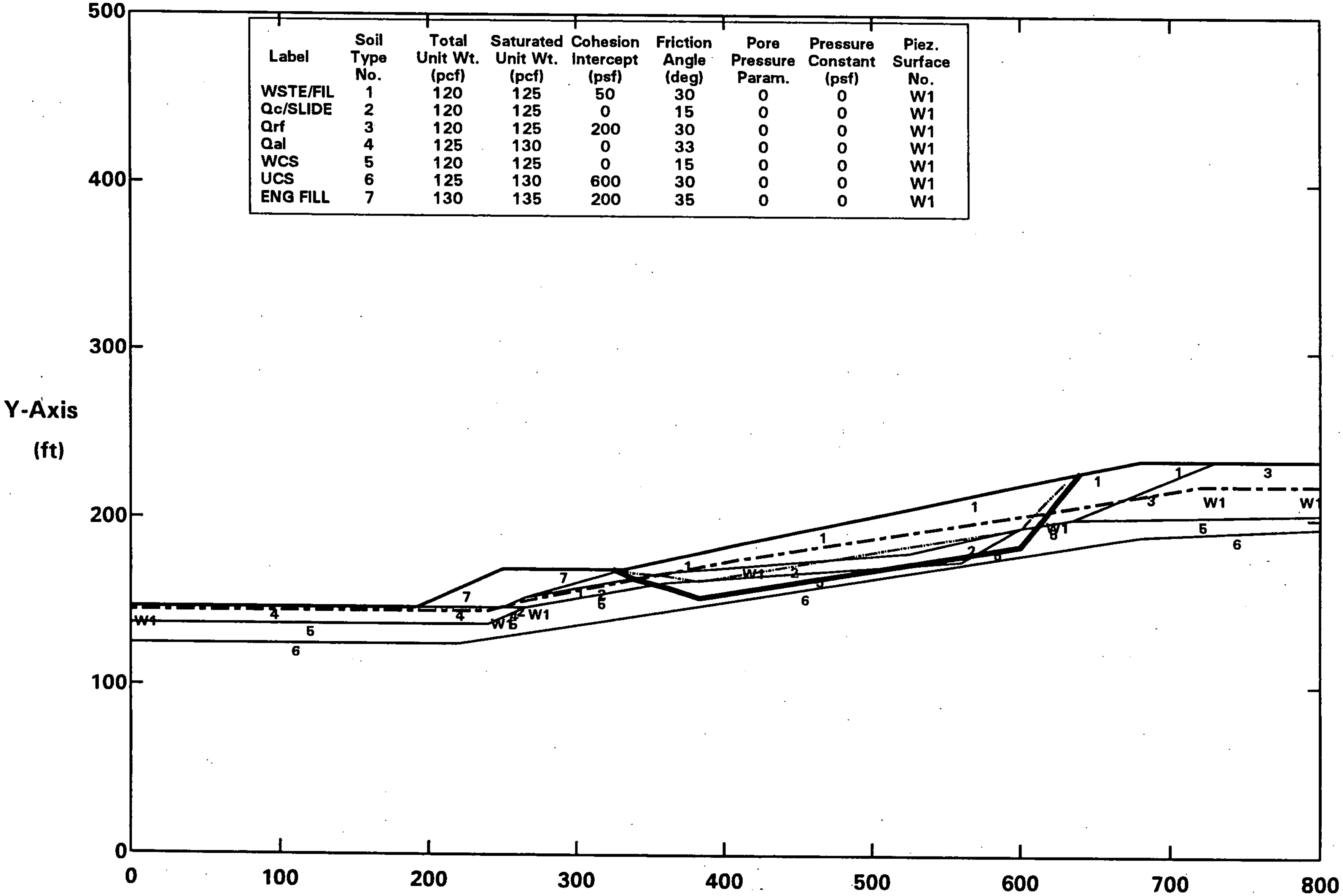
All surfaces evaluated. C:BBAS06.PLT By: STAN KLINE 10-26-04 12:48am



Factors Of Safety Calculated By The Modified Janbu Method

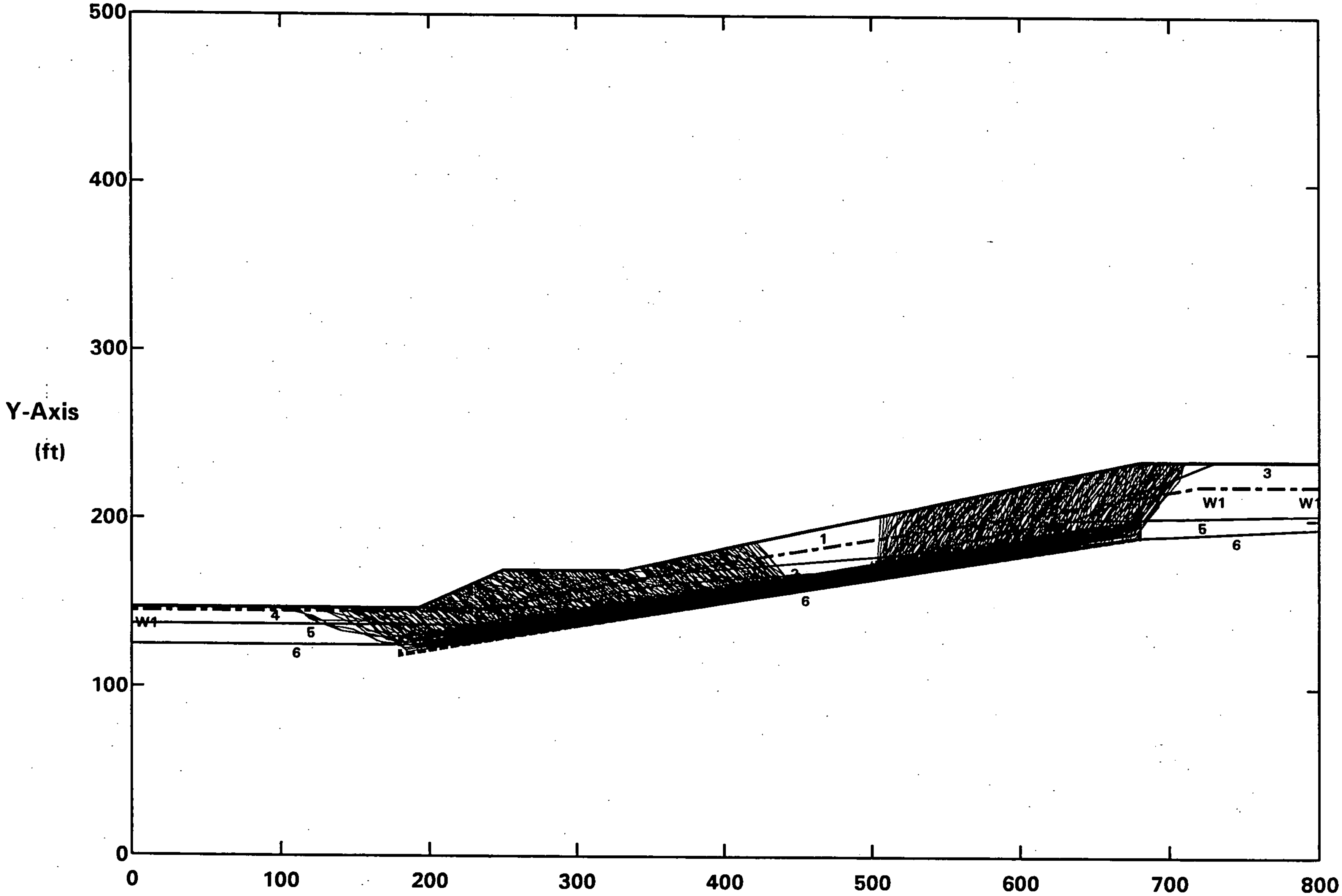
ROCKY FLATS OLF - M&E B 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-BBAS06.OUT. C:BBAS06SP.PLT By: STAN KLINE 10-26-04 12:49am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1



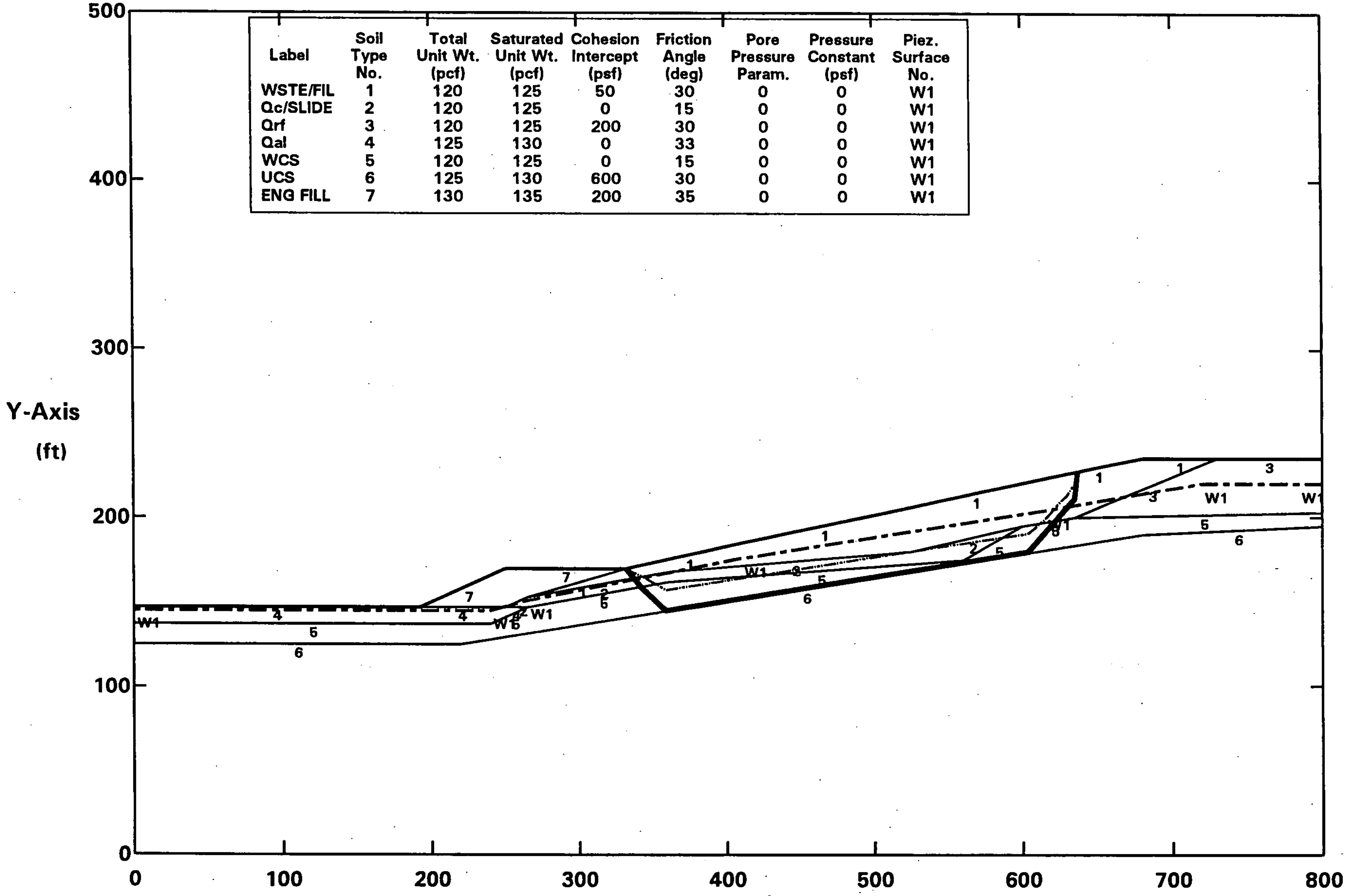
PCSTABL5M/SI FS = 0.95 Theta = 7.75 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E B 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.05g
All surfaces evaluated. C:BBAS05.PLT By: STAN KLINE 10-26-04 12:47am



Factors Of Safety Calculated By The Modified Janbu Method

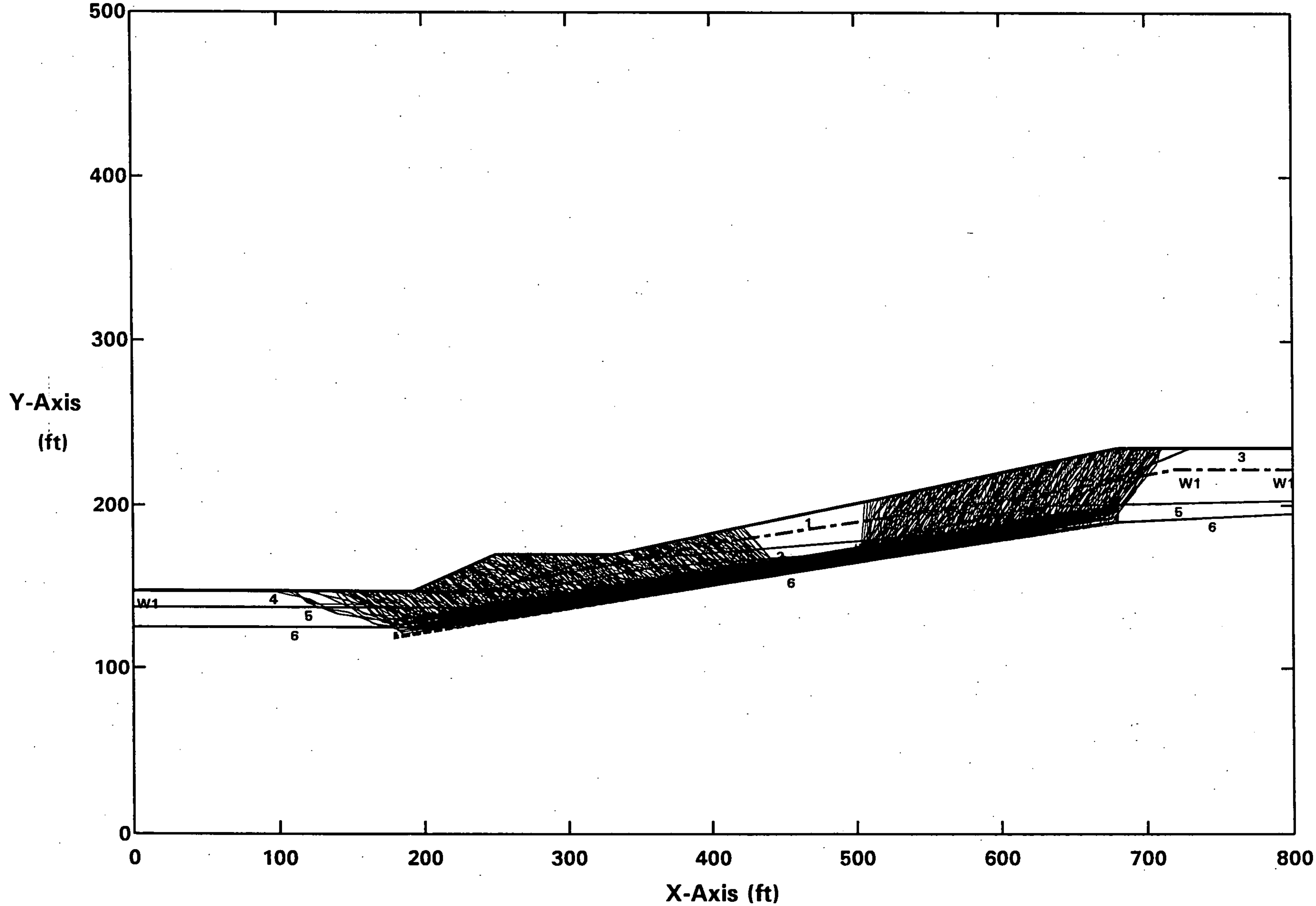
ROCKY FLATS OLF - M&E B 18%W/BM - WCS=15 deg - W/AVEGW - SLIDING BLOCK - 0.05g
Surface #1-BBAS05.OUT. C:BBAS05SP.PLT By: STAN KLINE 10-26-04 12:48am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

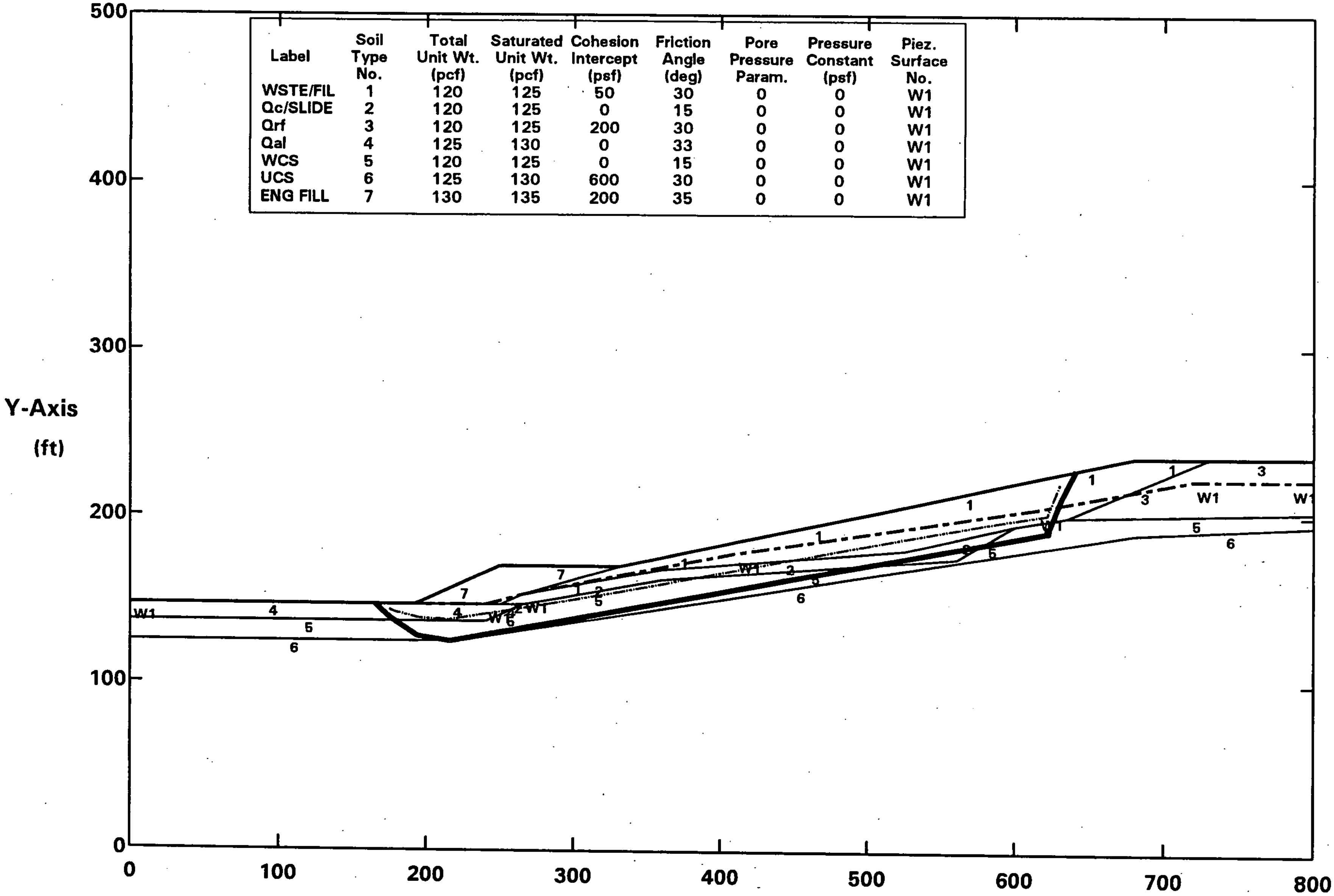
PCSTABL5M/SI FS=1.05 Theta=6.9 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E B 18%W/BM - WCS= 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:BBHS06.PLT By: STAN KLINE 10-24-04 6:24pm



Factors Of Safety Calculated By The Modified Janbu Method

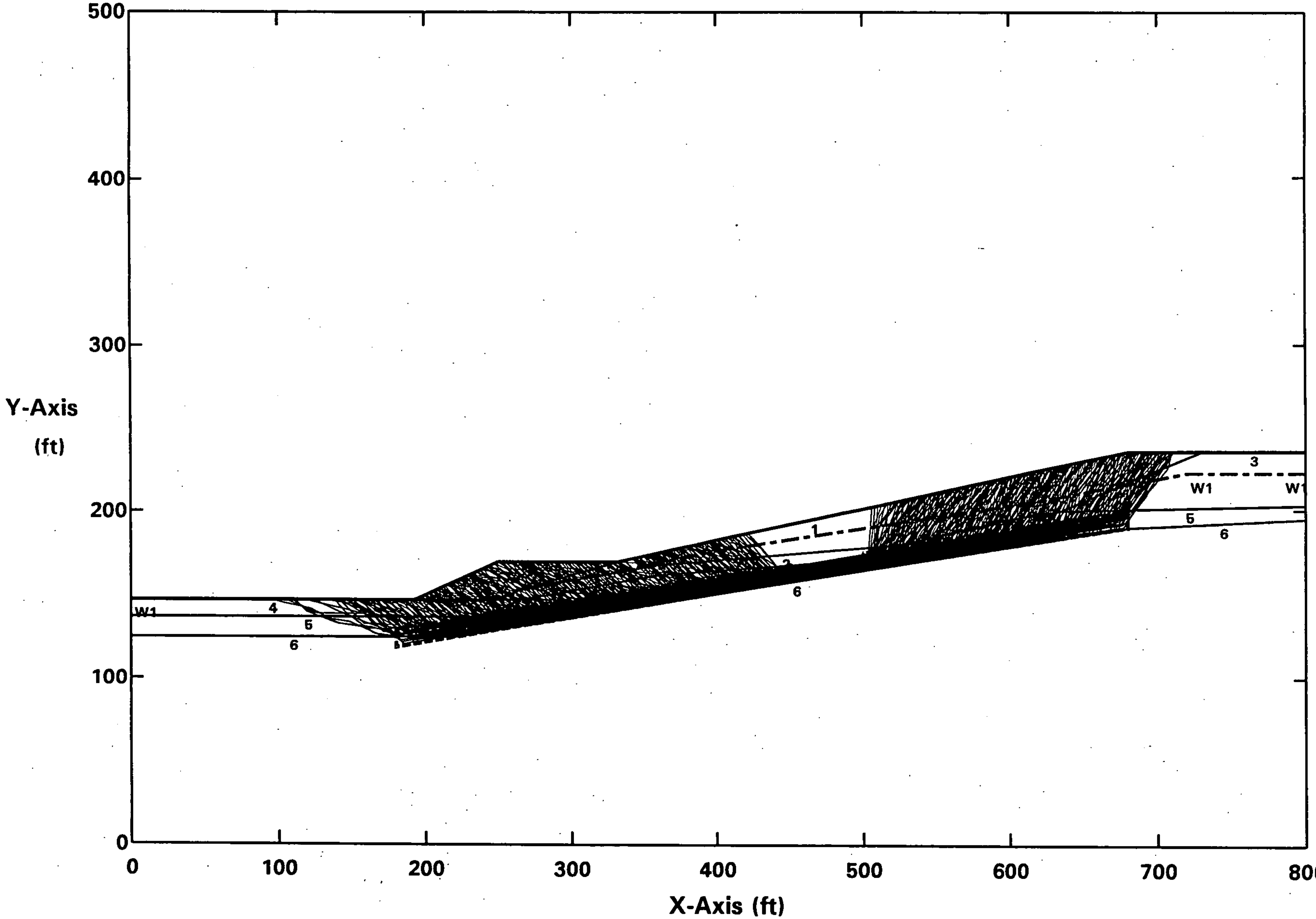
ROCKY FLATS OLF - M&E B 18%W/BM - WCS=15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-BBHS06.OUT. C:BBHS06SP.PLT By: STAN KLINE 10-24-04 6:27pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

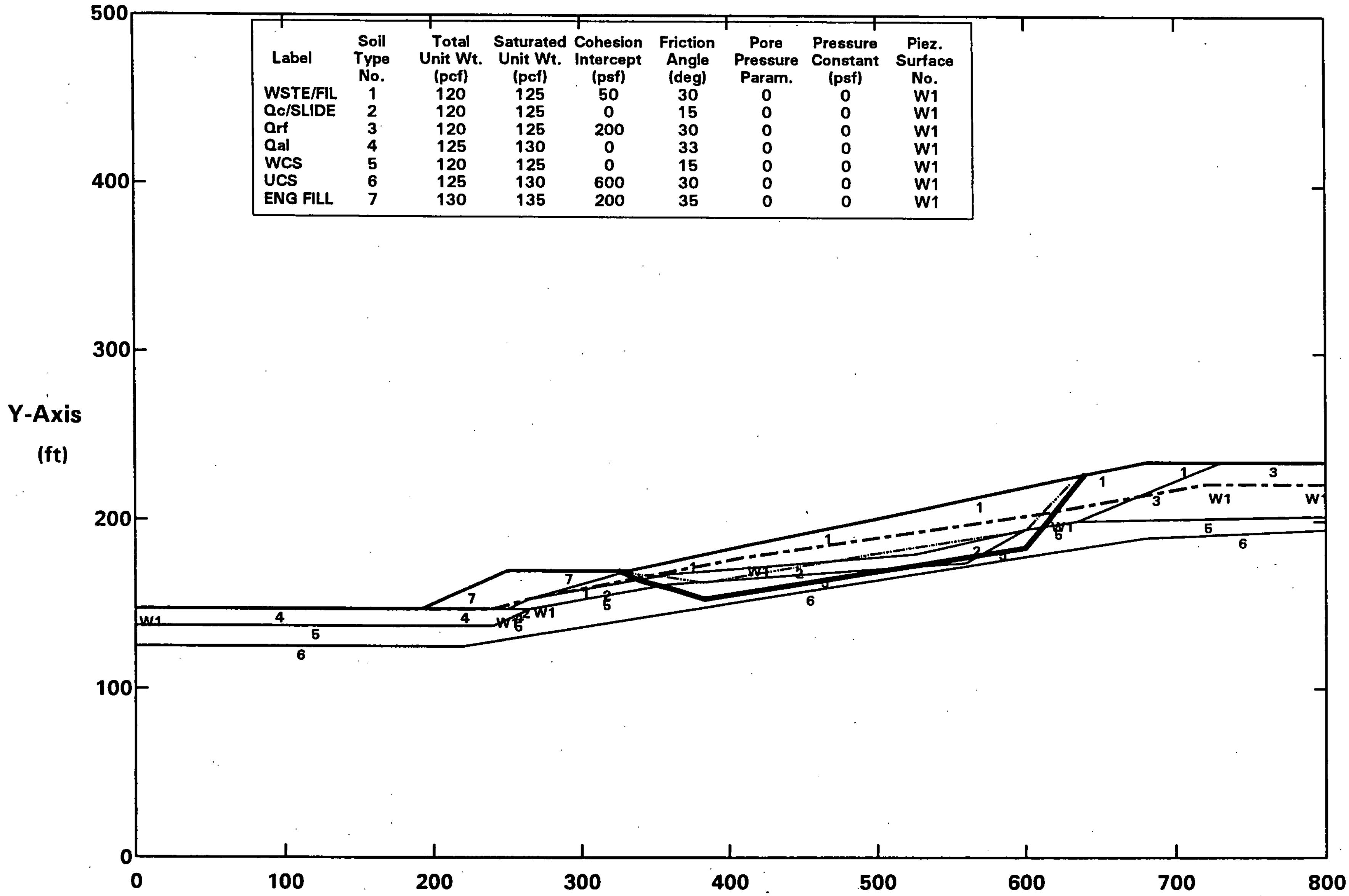
PCSTABL5M/SI FS=0.92 Theta=7.5 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E B 18%W/BM - WCS= 15 deg - W/HIGHGW - SLIDING BLOCK - 0.04g
All surfaces evaluated. C:BBHS04.PLT By: STAN KLINE 10-24-04 6:11pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E B 18%W/BM - WCS=15 deg - W/HIGHGW - SLIDING BLOCK - 0.04g
Surface #1-BBHS04.OUT. C:BBHS04SP.PLT By: STAN KLINE 10-24-04 6:13pm



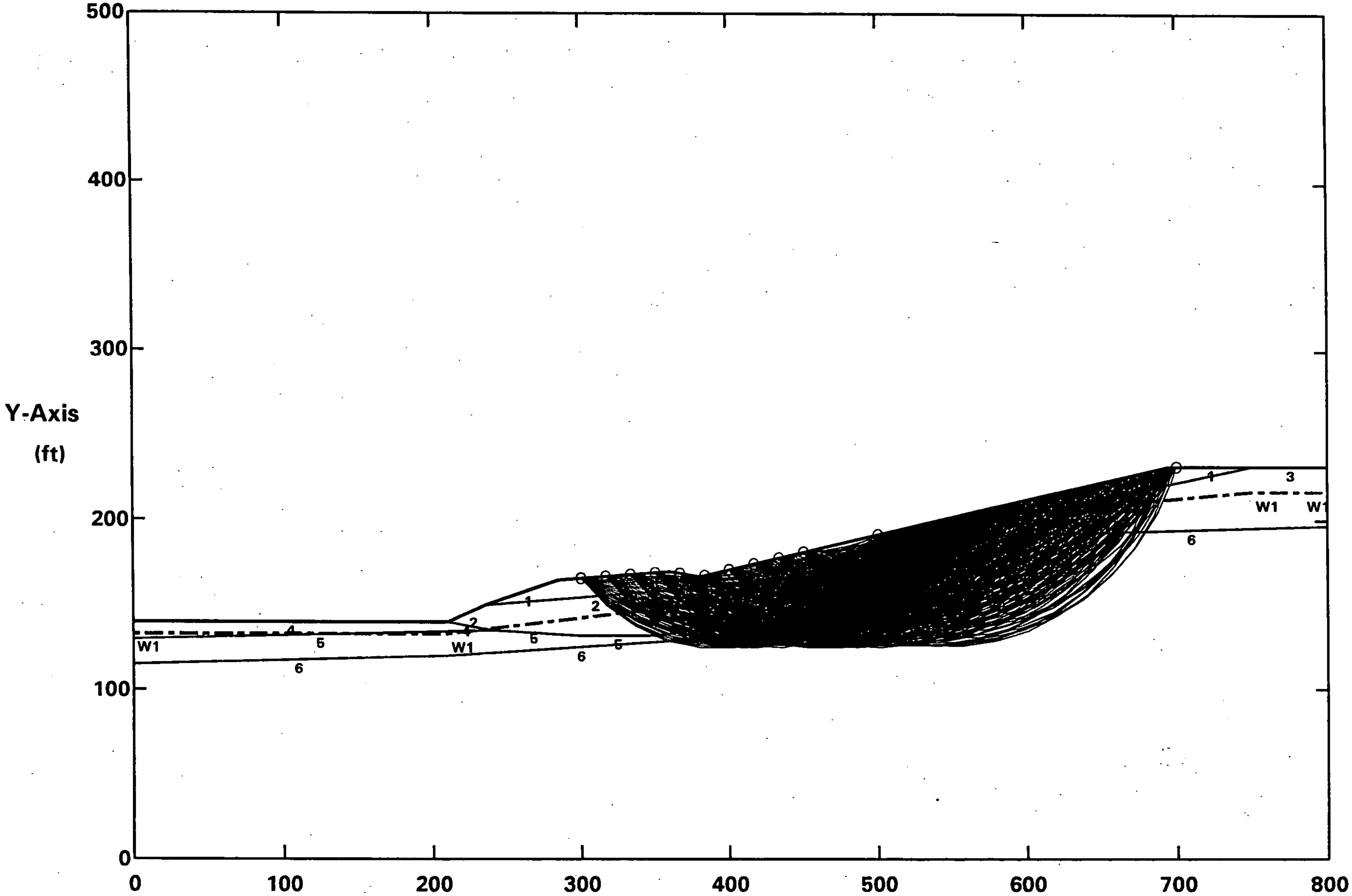
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FS=1.01 Theta=7.89 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

M&E SECTION C-C' – PSEUDOSTATIC

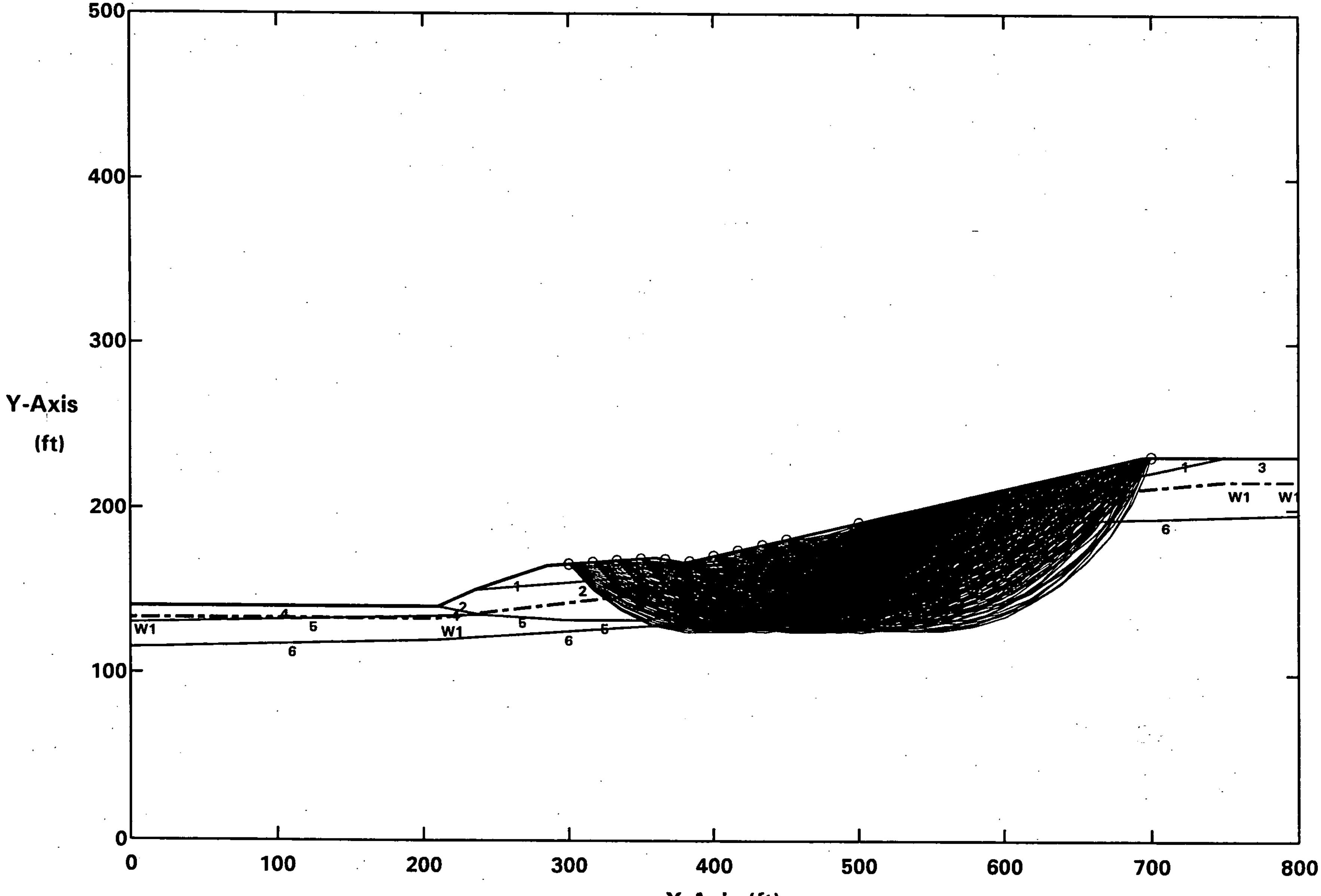
EXISTING CONDITIONS

ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.01g
All surfaces evaluated. C:CEAC01.PLT By: STAN KLINE 10-26-04 12:10am



X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

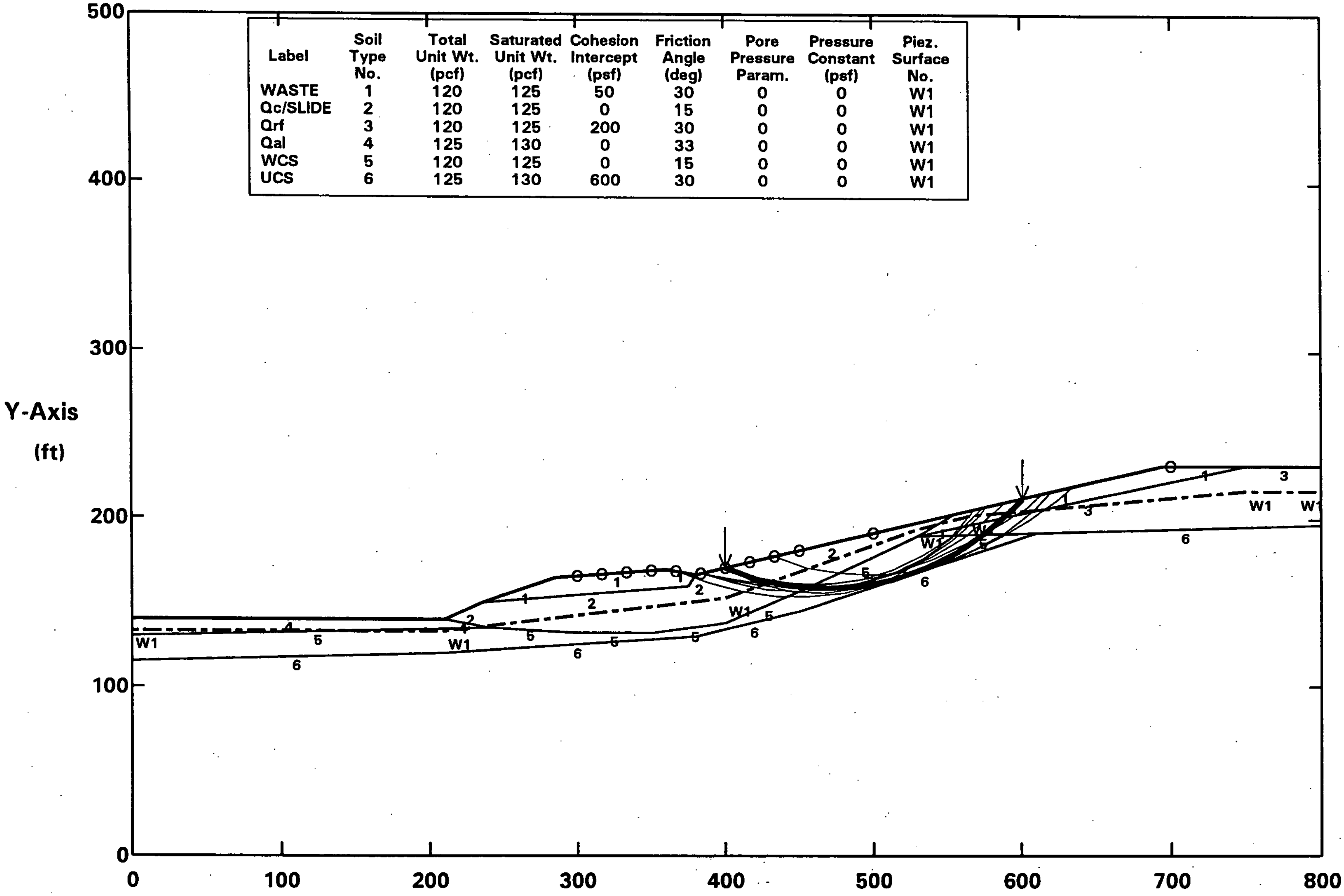
ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:CEAC06.PLT By: STAN KLINE 10-26-04 12:11am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.01g
Ten Most Critical. C:CEAC01.PLT By: STAN KLINE 10-26-04 12:10am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

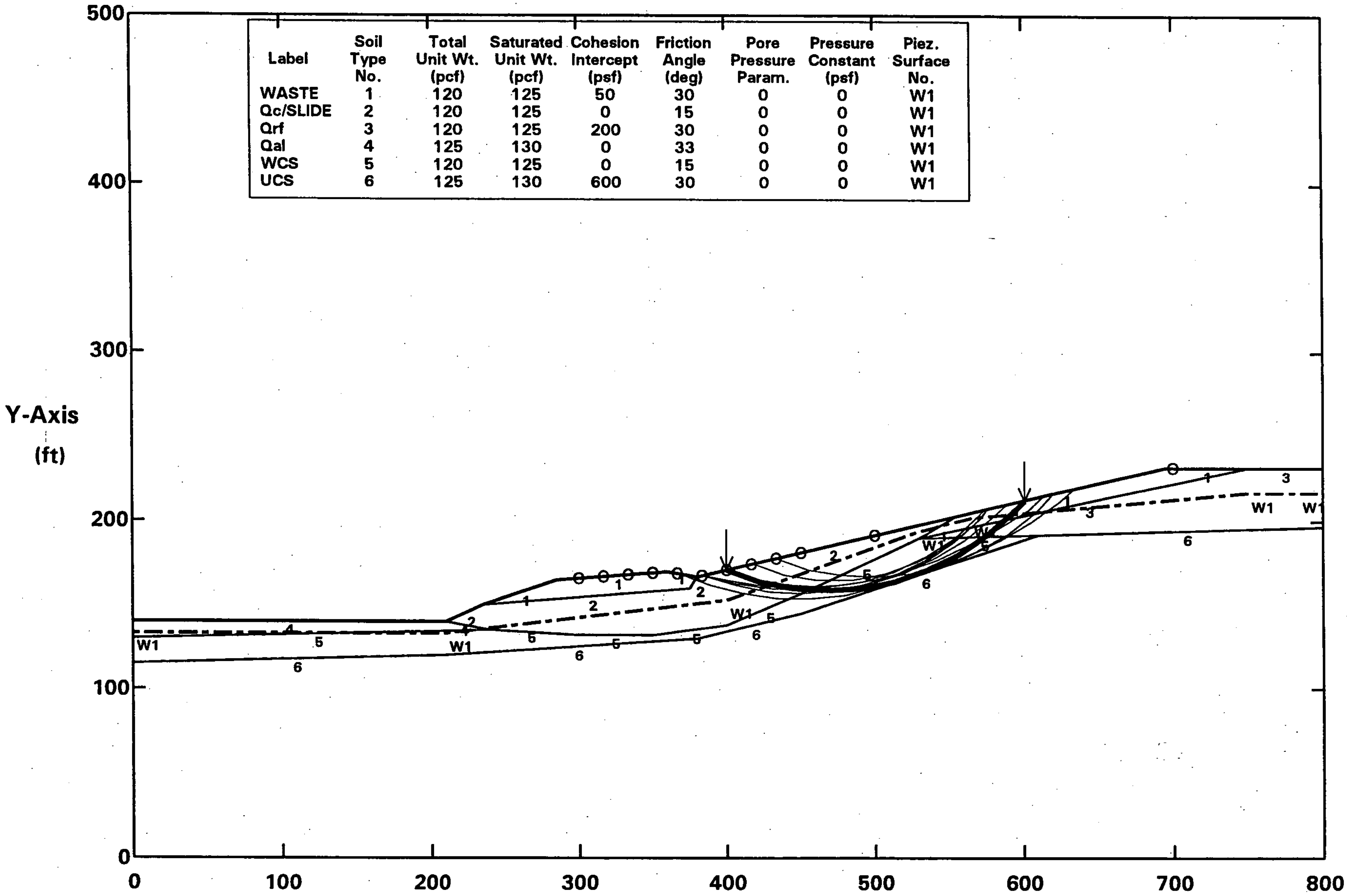


PCSTABL5M/SI FSmin = 1.03 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g

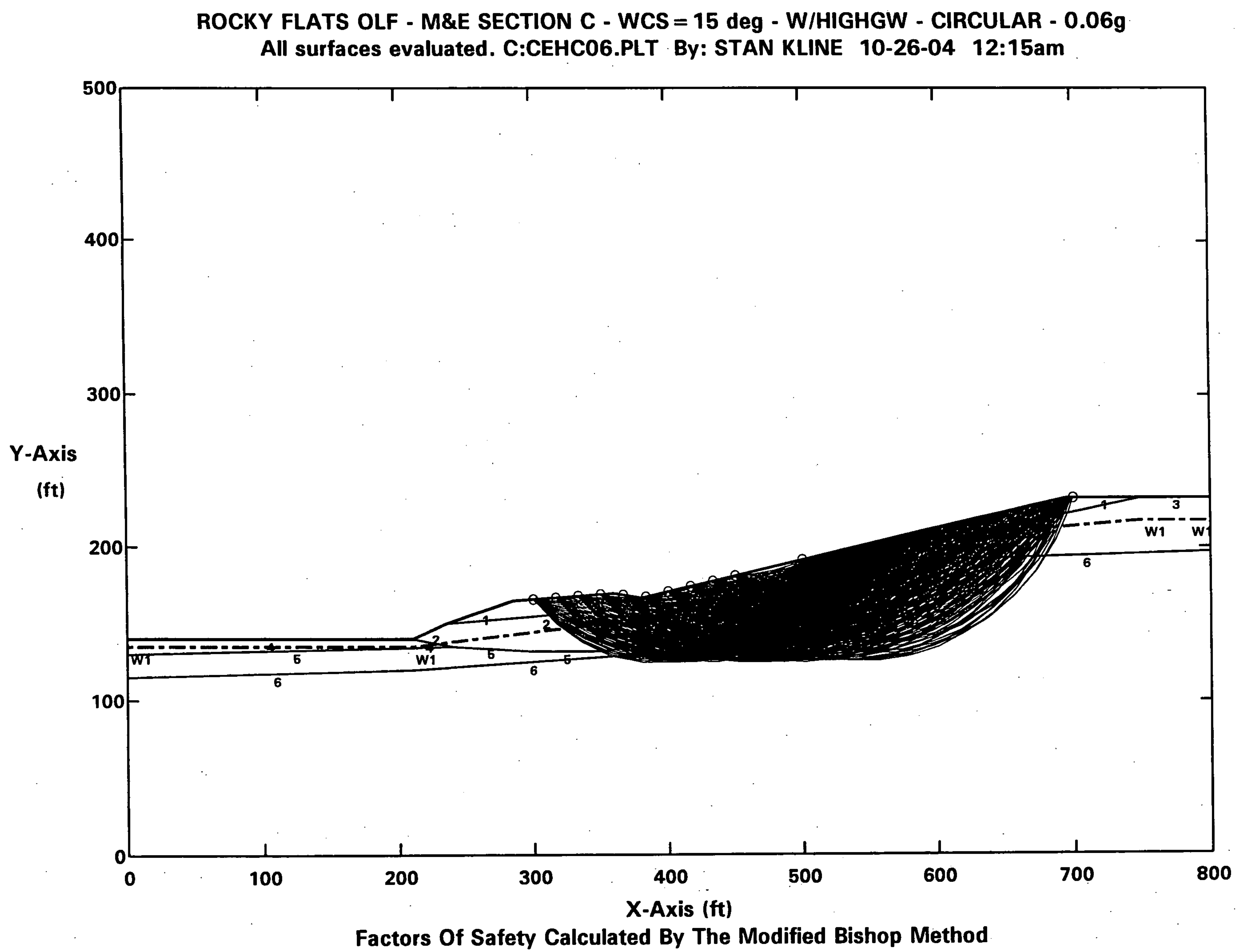
Ten Most Critical. C:CEAC06.PLT By: STAN KLINE 10-26-04 12:11am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



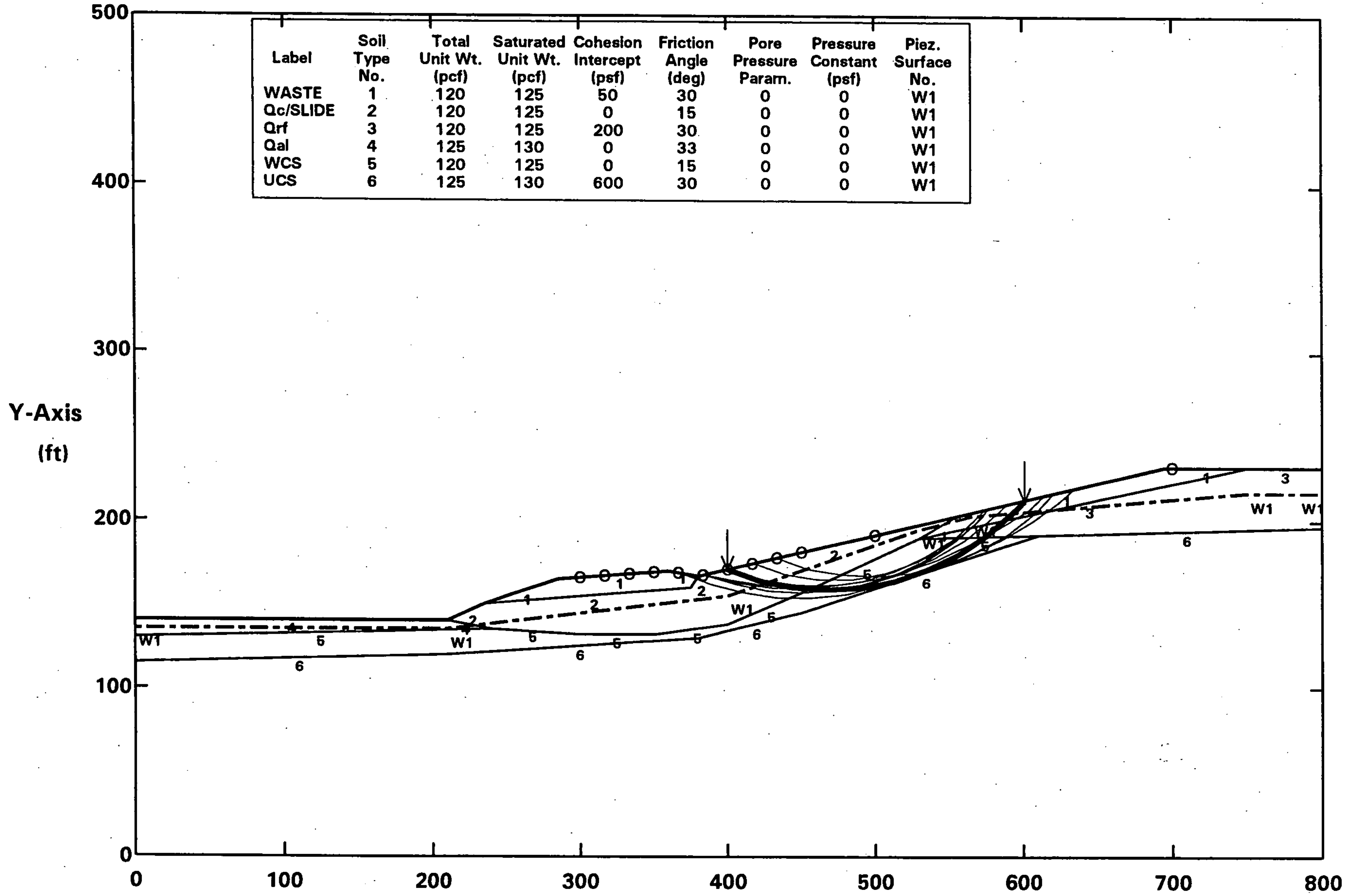
PCSTABL5M/SI FSmin = 0.83 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method



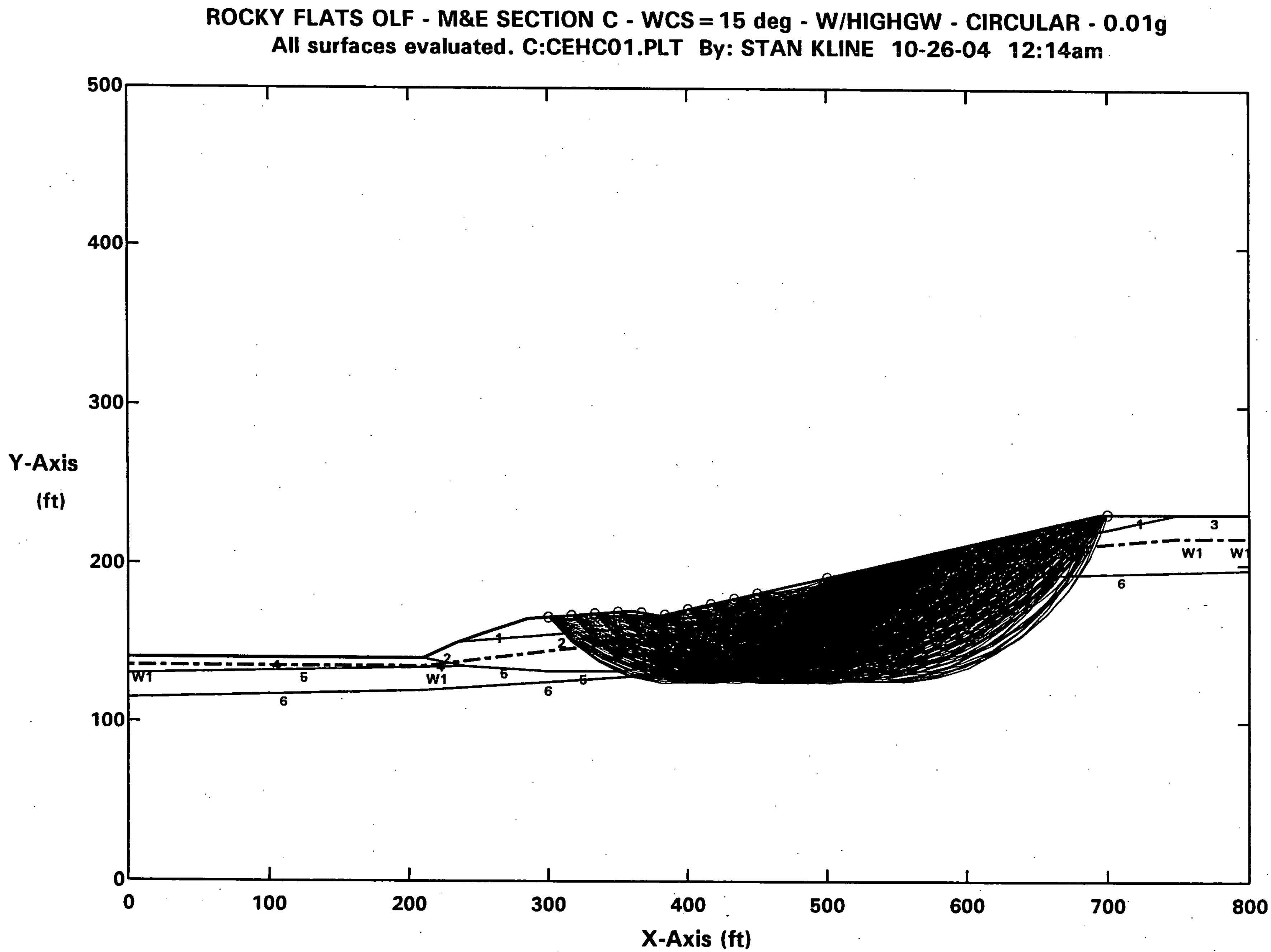
ROCKY FLATS OLF - M&E SECTION C - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.06g
All surfaces evaluated. C:CEHC06.PLT By: STAN KLINE 10-26-04 12:15am
Y-Axis
(ft)
500
400
300
200
100
0
100
200
300
400
500
600
700
800
1
2
3
4
5
6
W1
X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:CEHC06.PLT By: STAN KLINE 10-26-04 12:15am



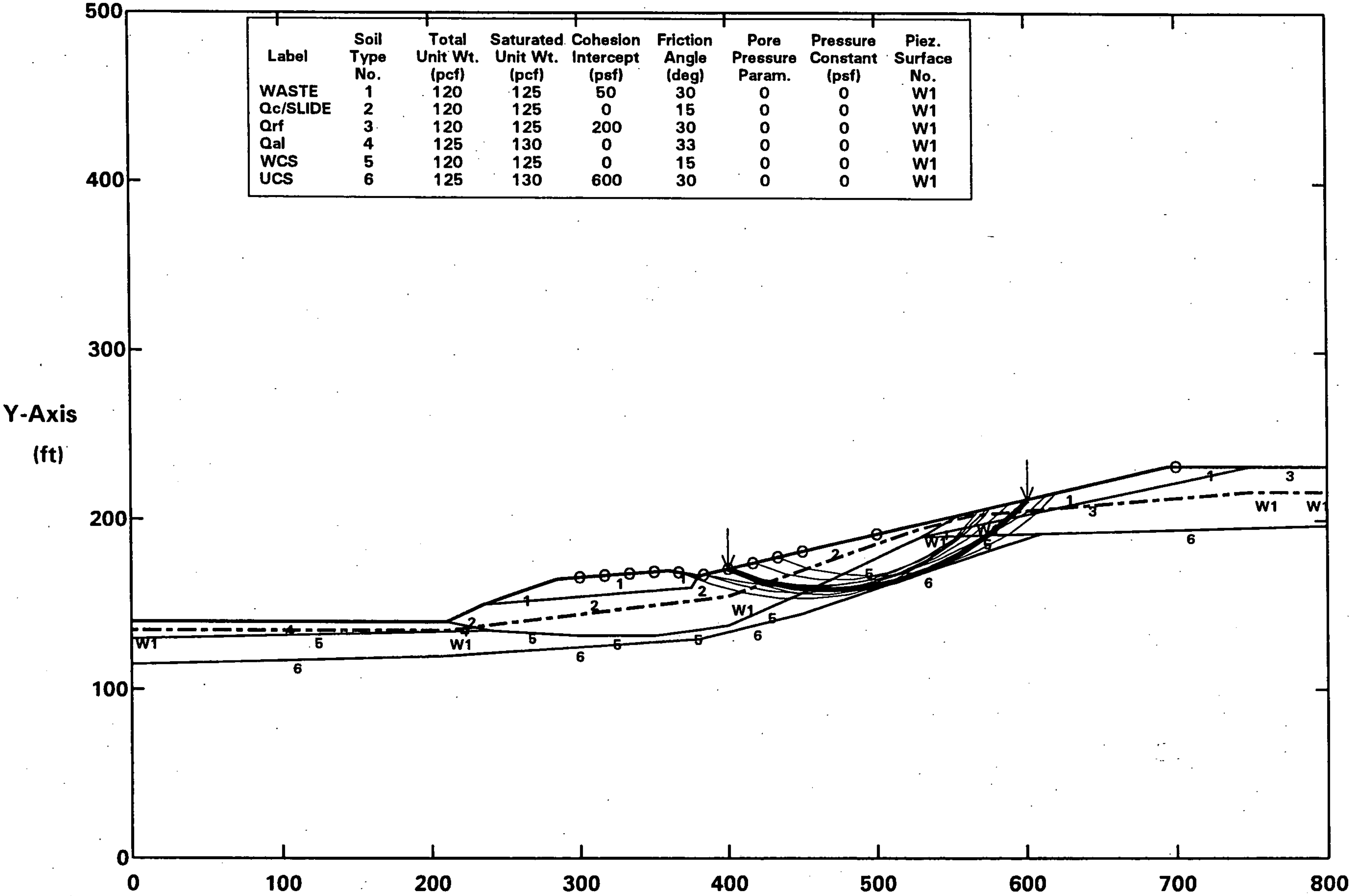
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 0.80 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method



Factors Of Safety Calculated By The Modified Bishop Method

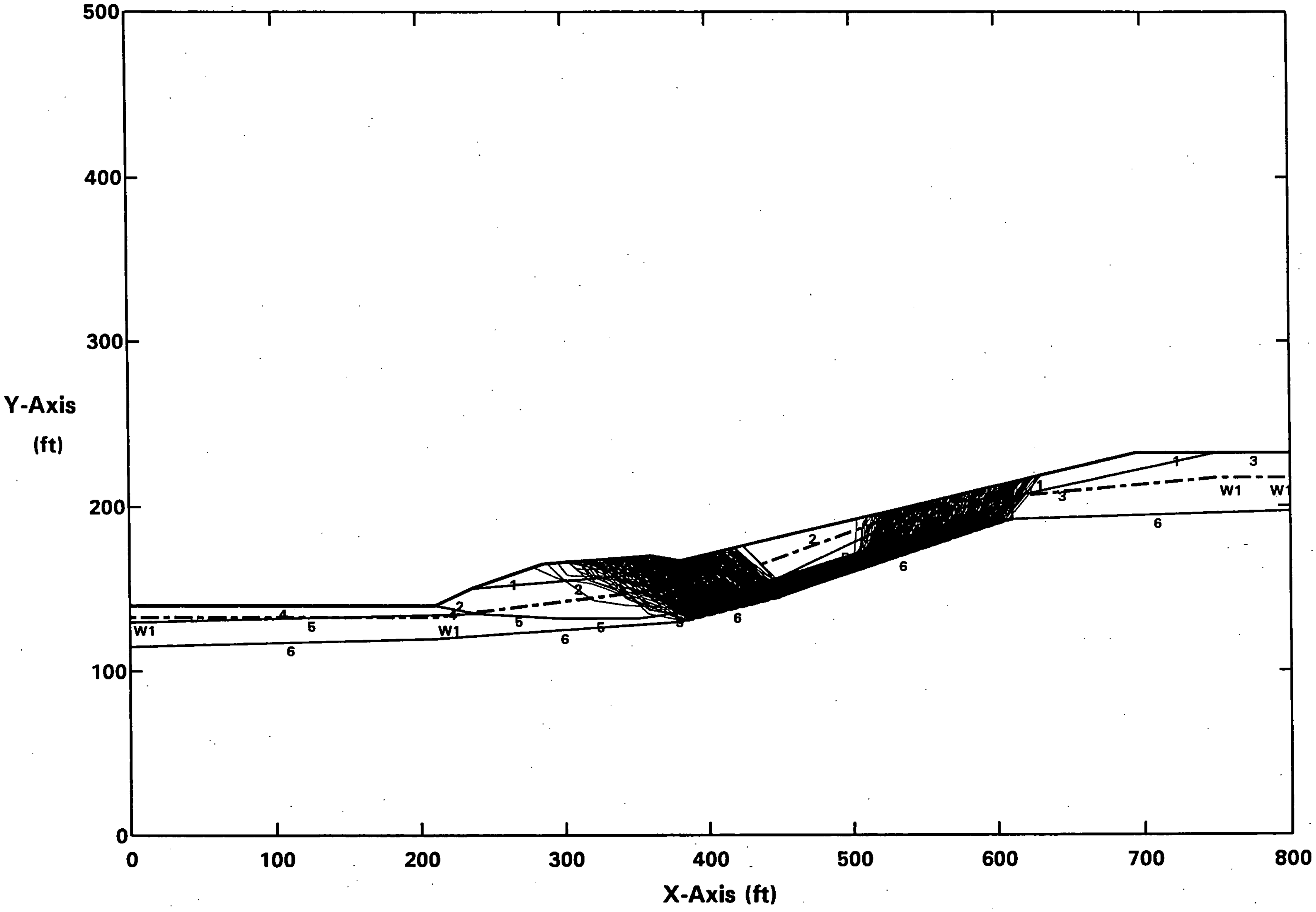
ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.01g
Ten Most Critical. C:CEHC01.PLT By: STAN KLINE 10-26-04 12:14am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

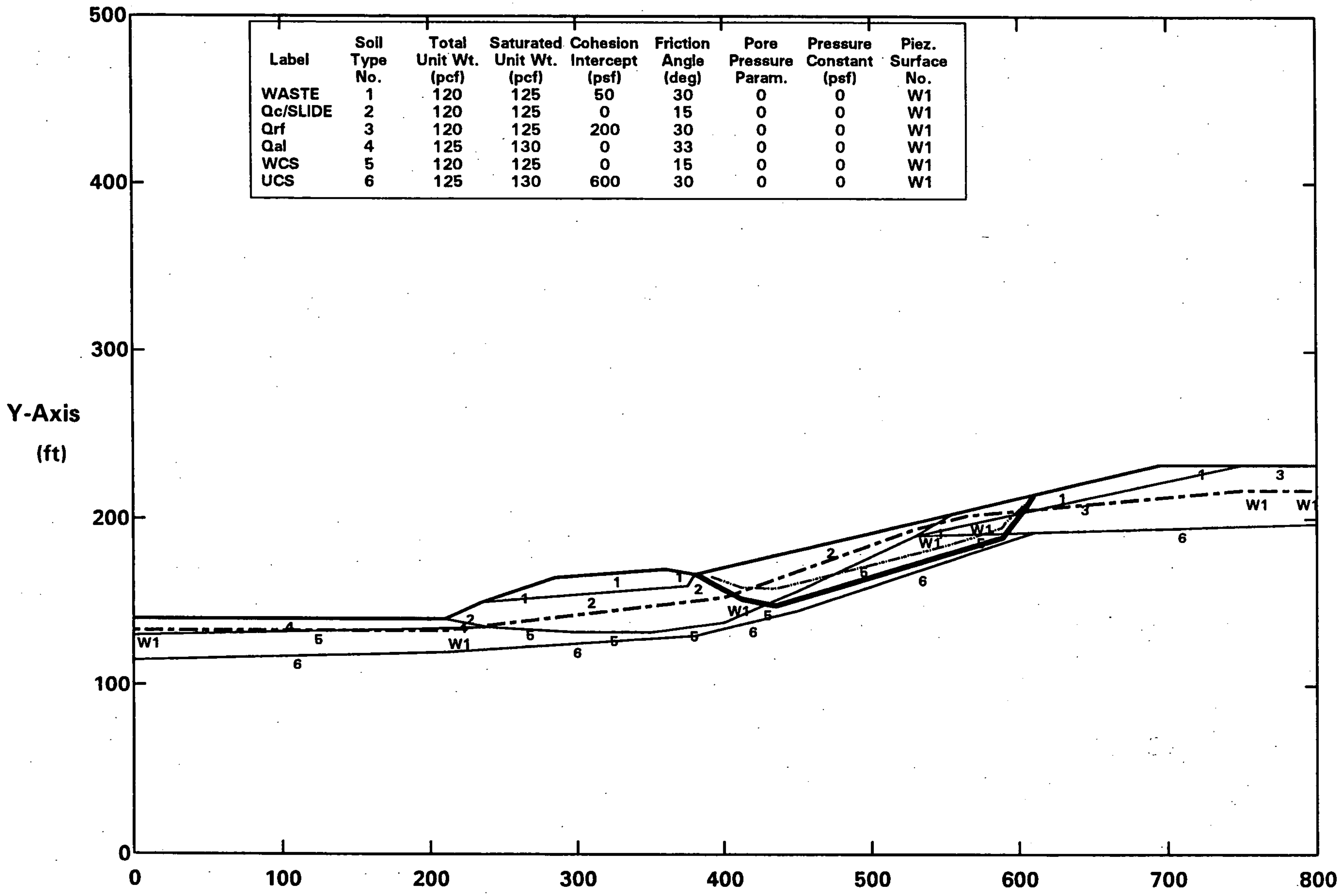
PCSTABL5M/SI FSmin = 1.00 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:CEAS06.PLT By: STAN KLINE 10-24-04 6:52pm



Factors Of Safety Calculated By The Modified Janbu Method

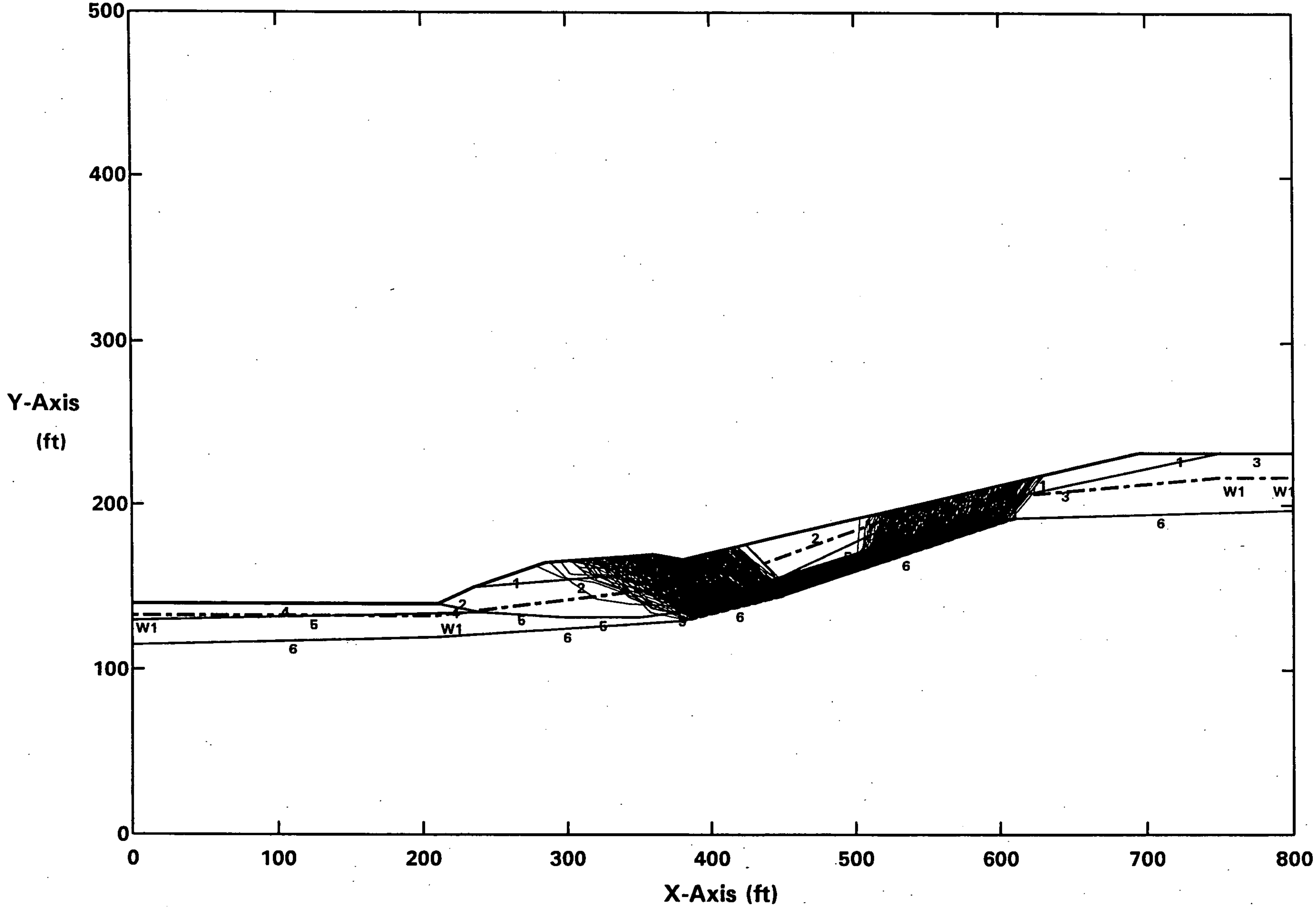
ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-CEAS06.OUT. C:CEAS06SP.PLT By: STAN KLINE 10-24-04 6:54pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

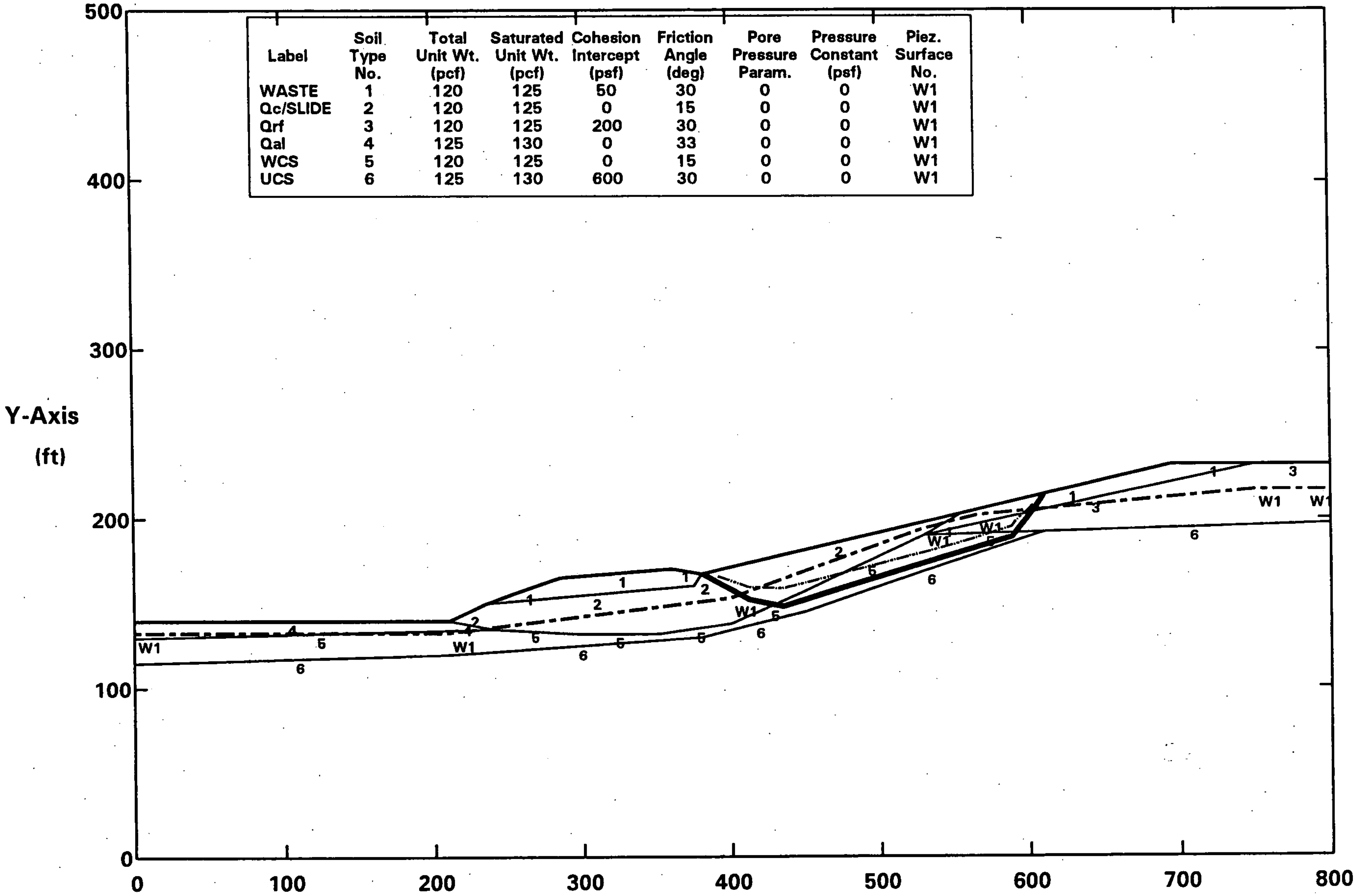
PCSTABL5M/SI FS = 0.85 Theta = 9.22 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.02g
All surfaces evaluated. C:CEAS02.PLT By: STAN KLINE 10-24-04 6:49pm



Factors Of Safety Calculated By The Modified Janbu Method

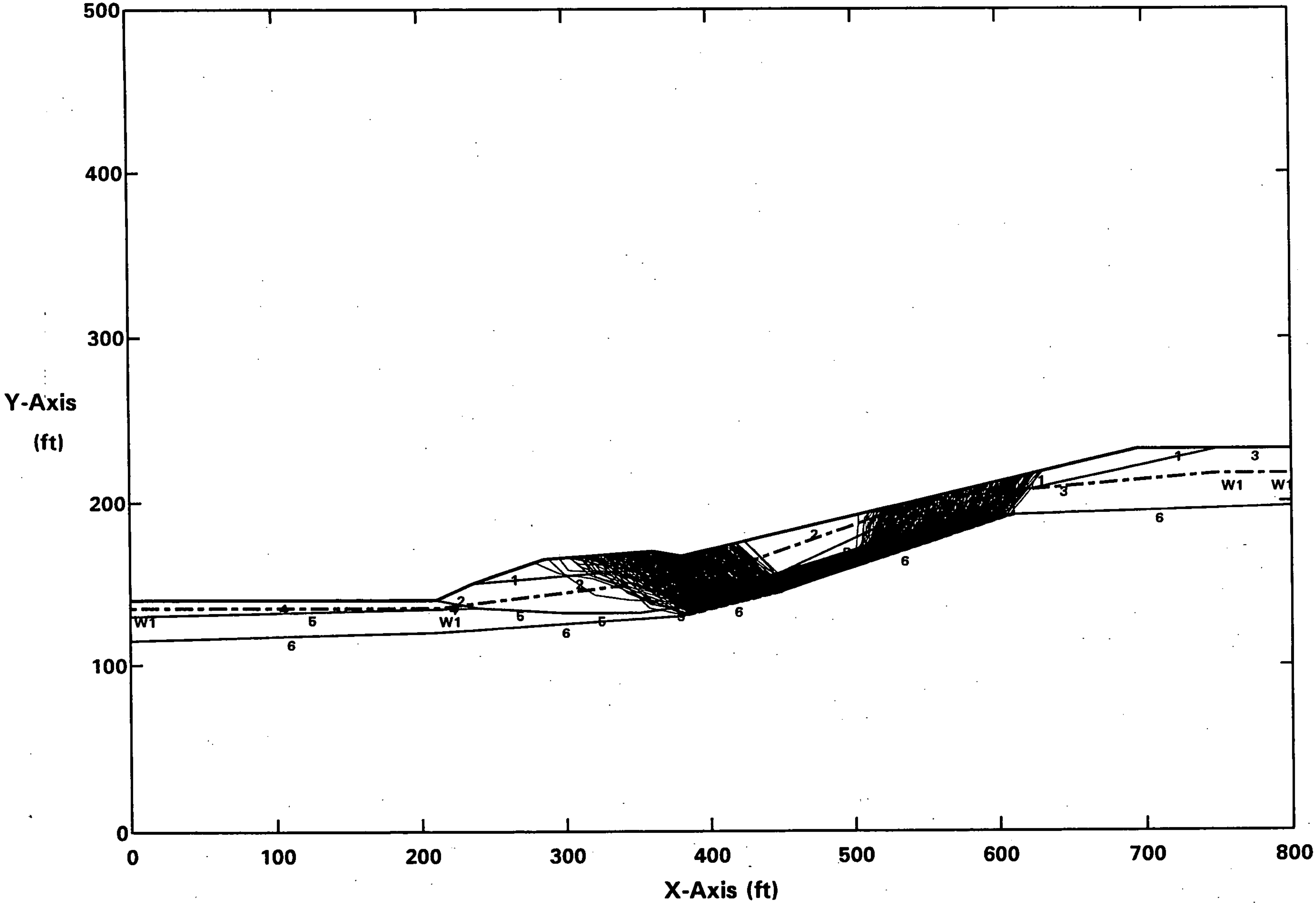
ROCKY FLATS OLF - M&E SECTION C - WCS=15 deg - W/AVEGW - SLIDING BLOCK - 0.02g
Surface #1-CEAS02.OUT. C:CEAS02SP.PLT By: STAN KLINE 10-24-04 6:51pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS=1.02 Theta=9.42 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

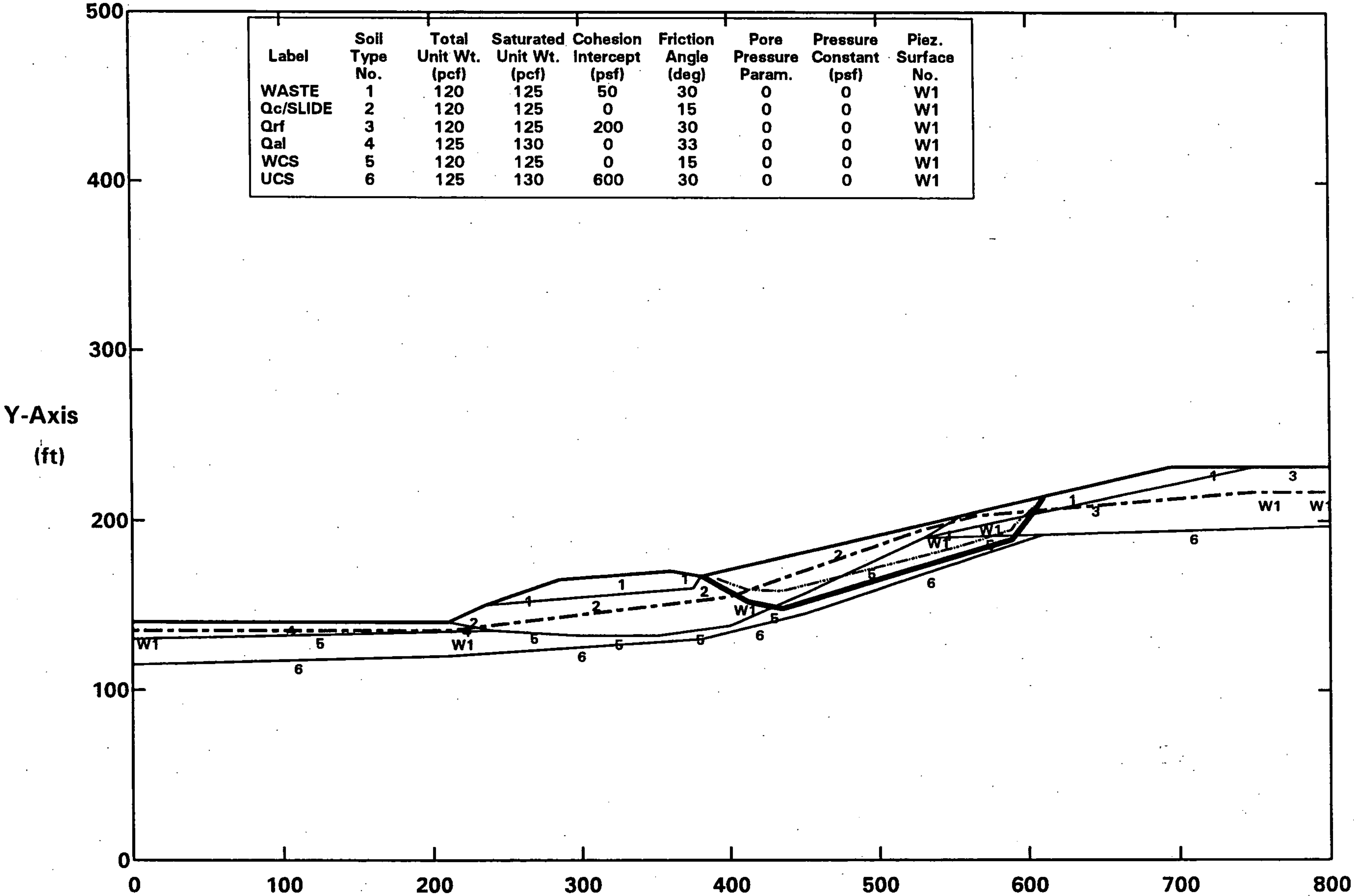
ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:CEHS06.PLT By: STAN KLINE 10-24-04 7:15pm



Factors Of Safety Calculated By The Modified Janbu Method

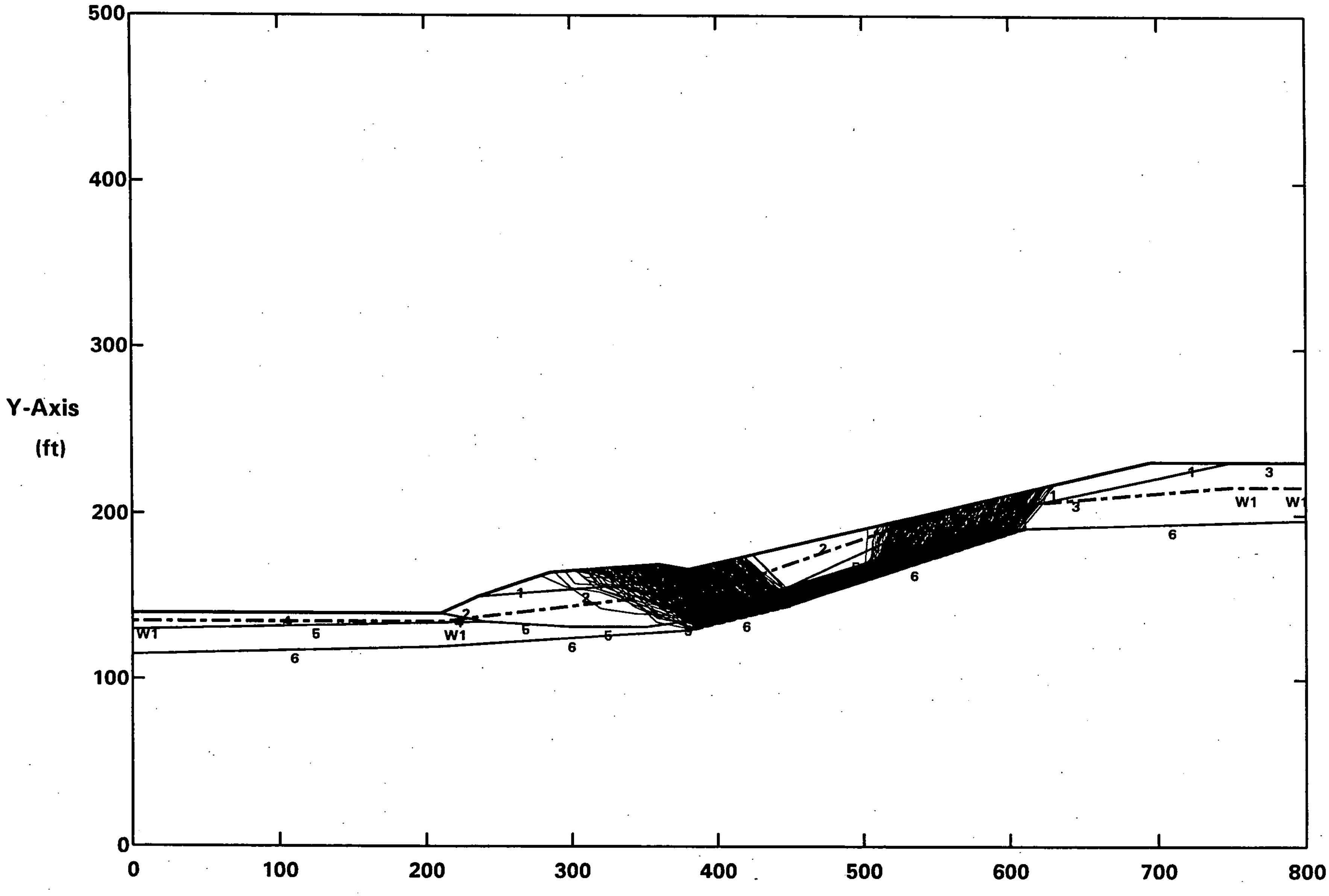
ROCKY FLATS OLF - M&E SECTION C - WCS=15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-CEHS06.OUT. C:CEHS06SP.PLT By: STAN KLINE 10-24-04 7:17pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



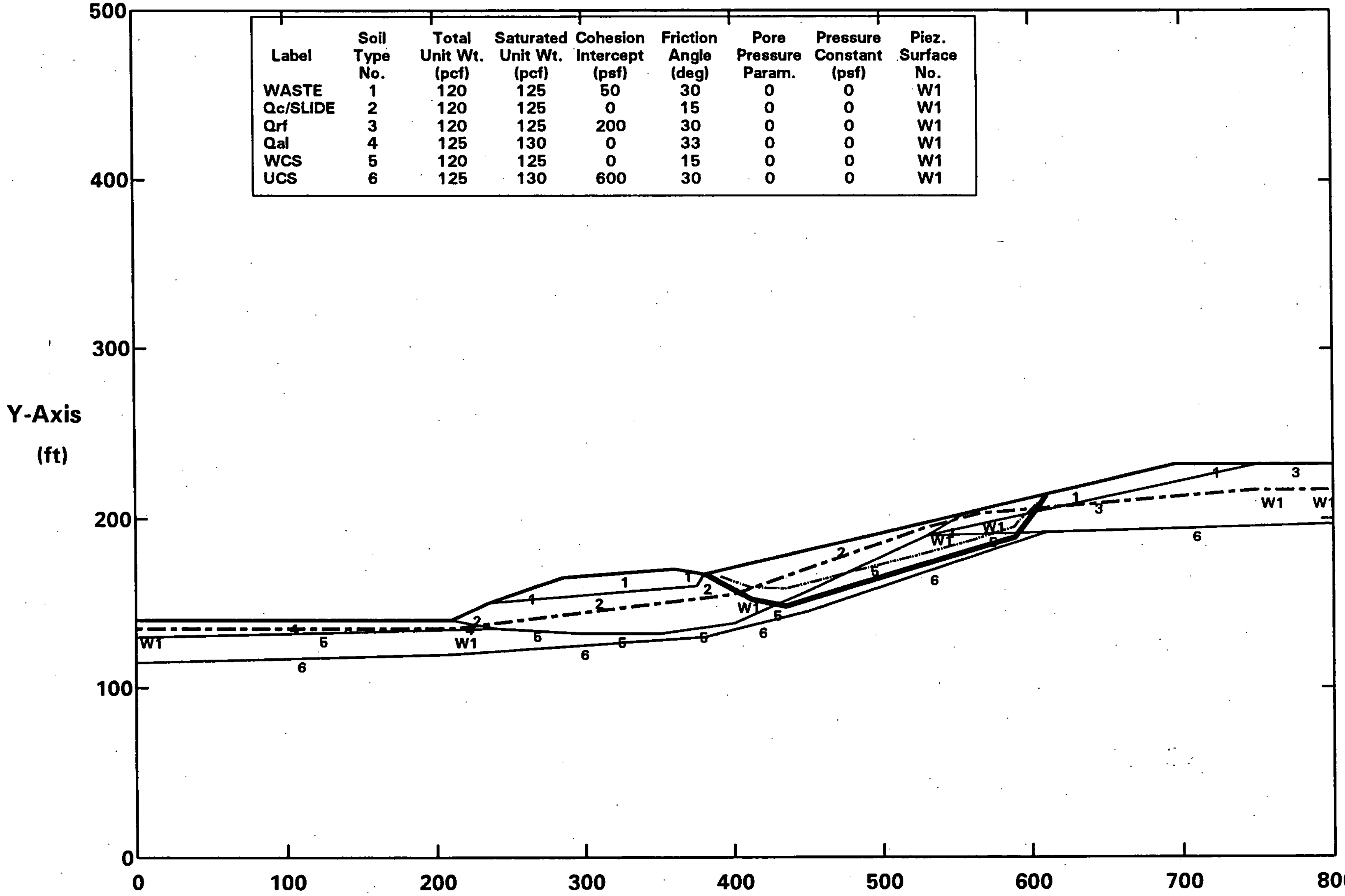
PCSTABL5M/SI FS=0.82 Theta=9.22 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E SECTION C - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.01g
All surfaces evaluated. C:CEHS01.PLT By: STAN KLINE 10-24-04 7:12pm



Factors Of Safety Calculated By The Modified Janbu Method

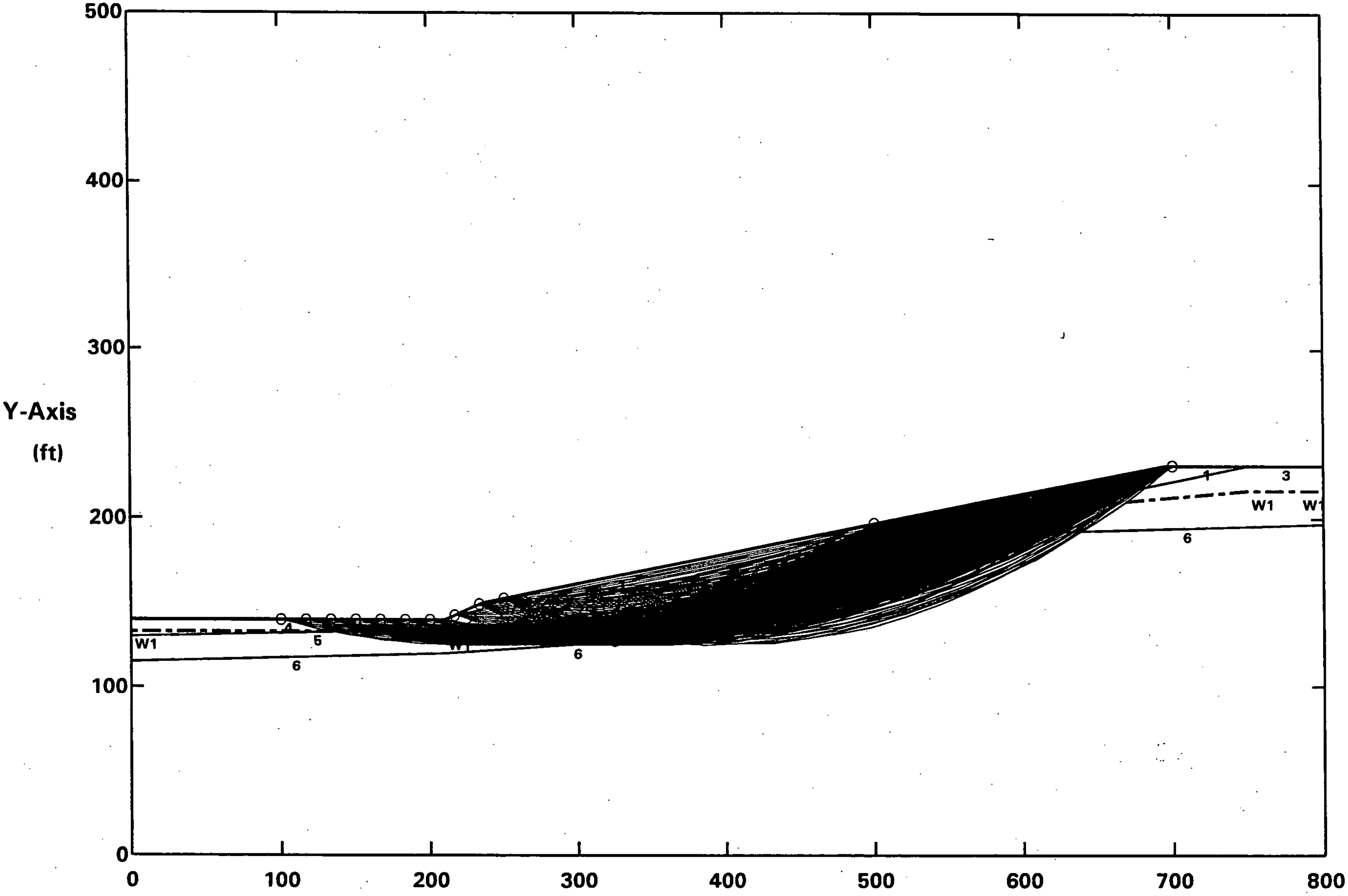
ROCKY FLATS OLF - M&E SECTION C - WCS=15 deg - W/HIGHGW - SLIDING BLOCK - 0.01g
Surface #1-CEHS01.OUT. C:CEHS01SP.PLT By: STAN KLINE 10-24-04 7:14pm



PCSTABL5M/SI FS=1.04 Theta=9.49 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

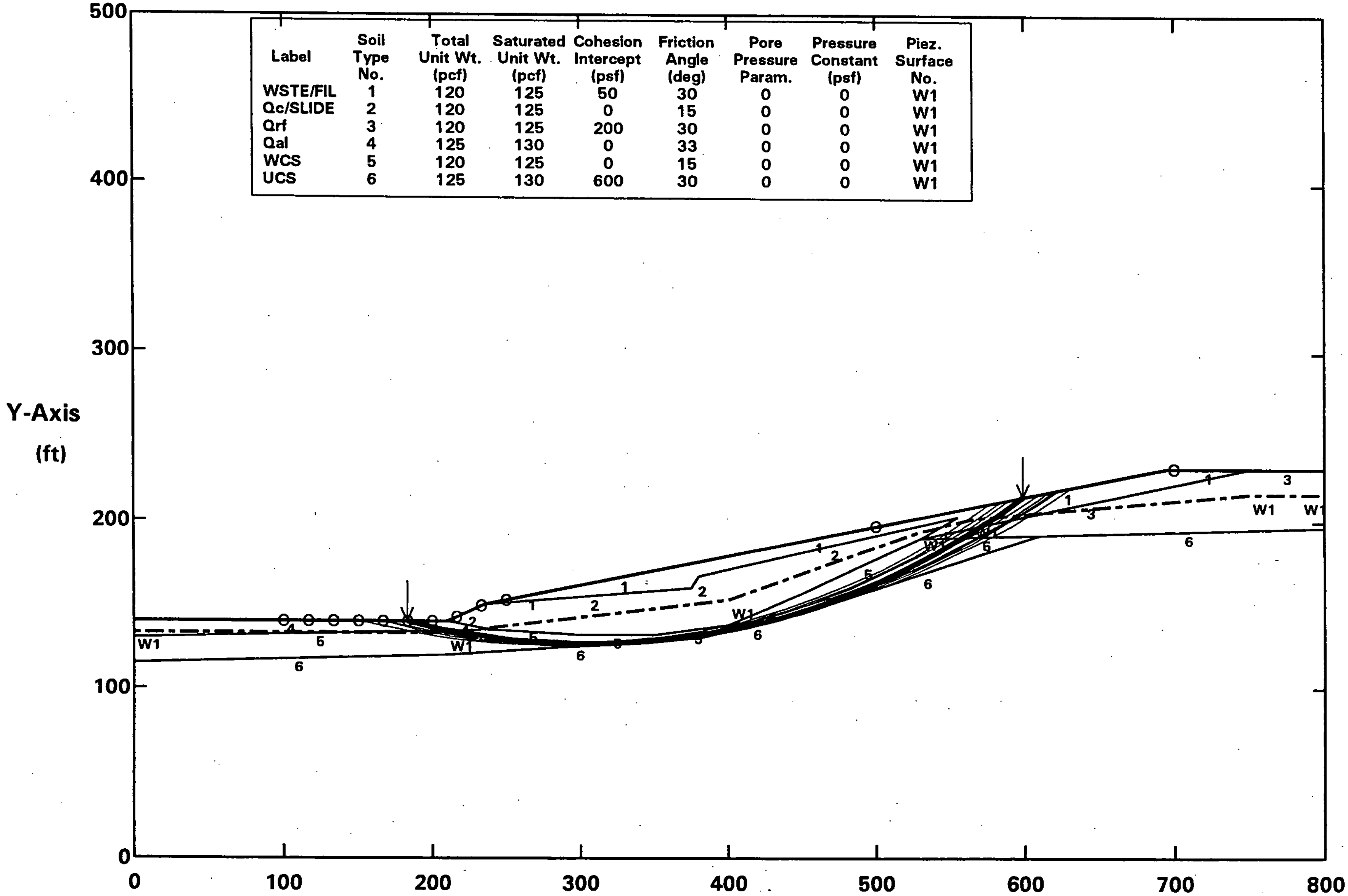
18% REGRADE CONDITION

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:CGAC06.PLT By: STAN KLINE 10-26-04 12:12am



X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

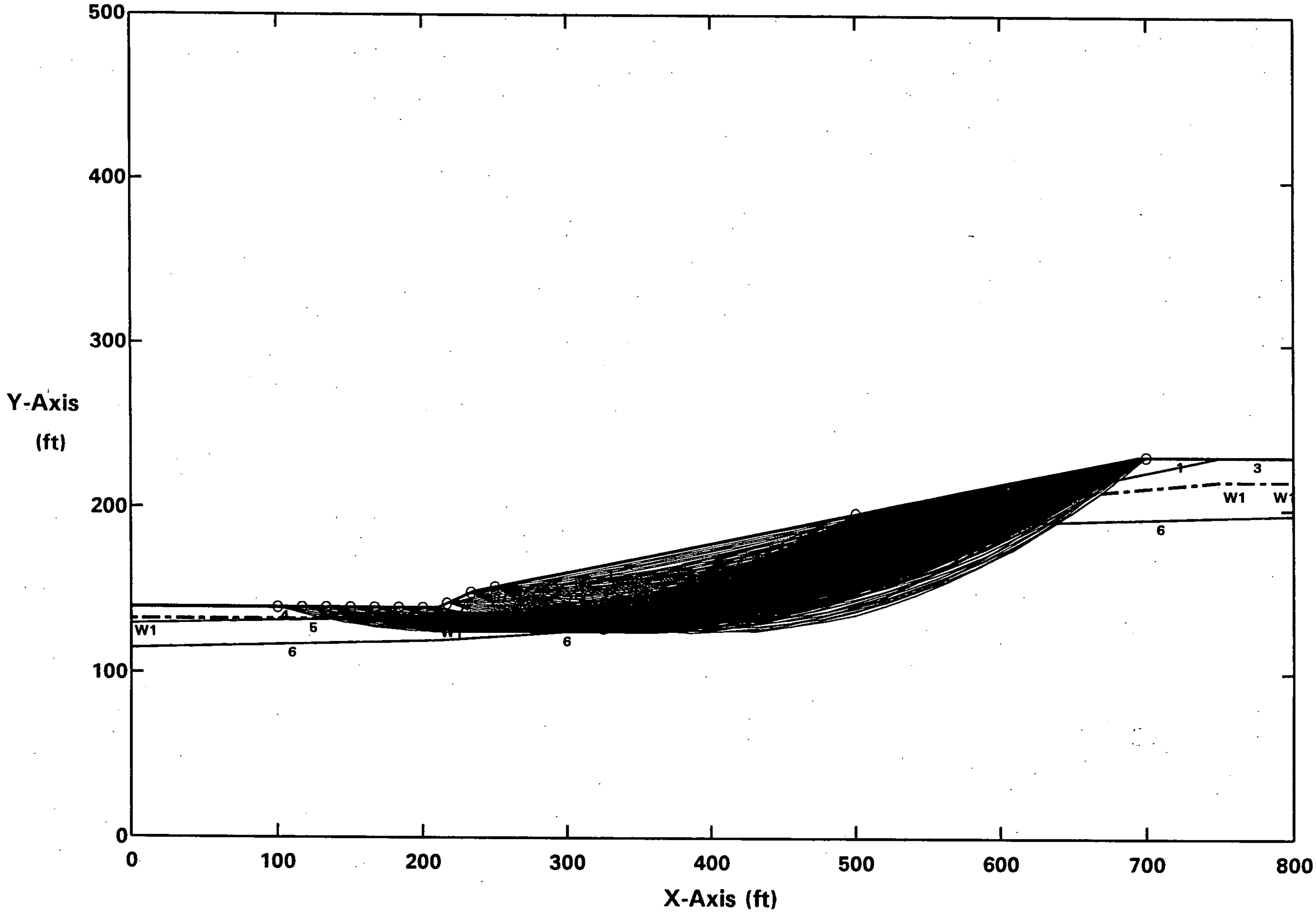
ROCKY FLATS OLF - M&E C 18% GRD - WCS=15 deg - W/AVEGW - CIRCULAR - 0.04g
Ten Most Critical. C:CGAC04.PLT By: STAN KLINE 10-26-04 12:12am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

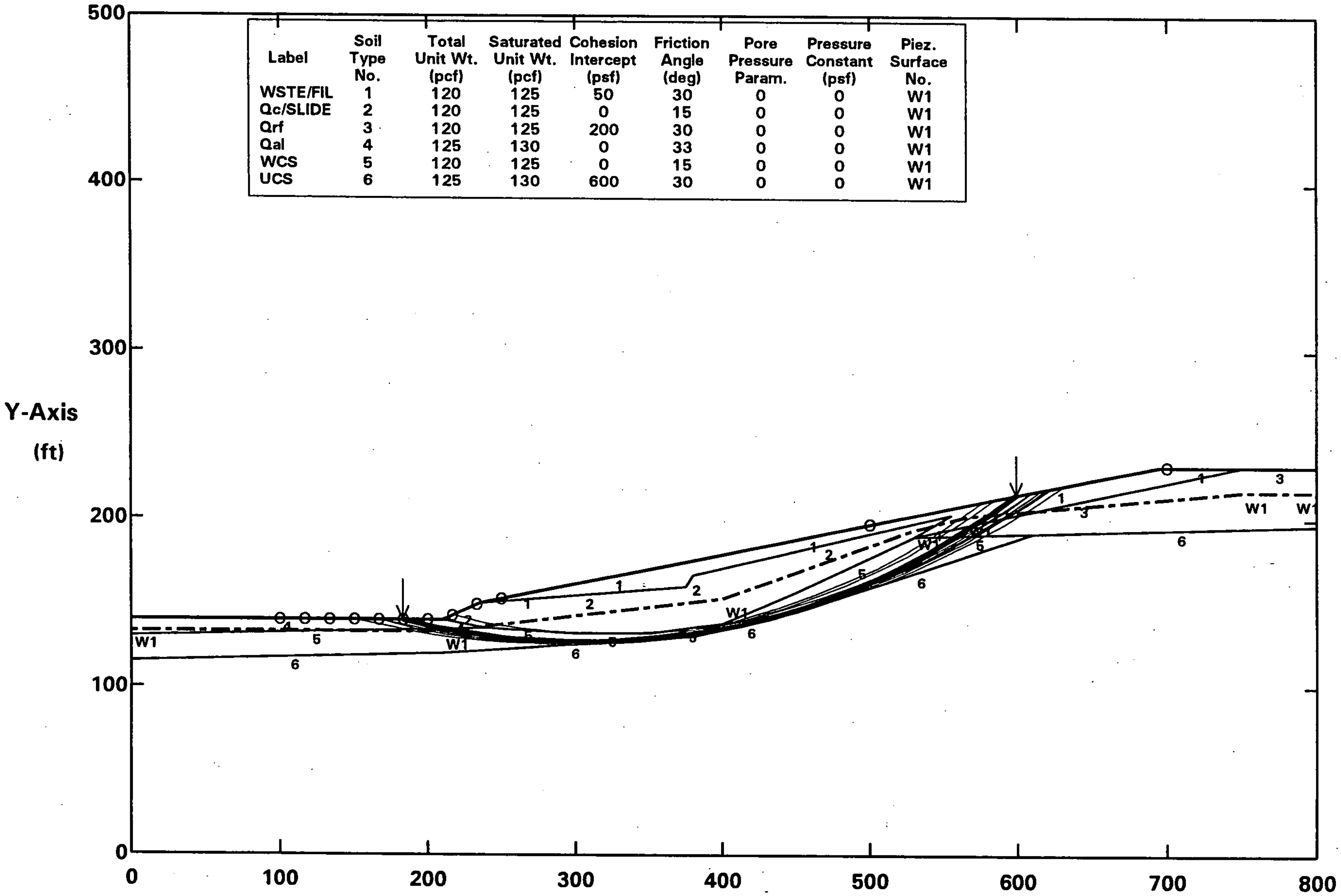
PCSTABL5M/SI FSmin=1.02 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.04g
All surfaces evaluated. C:CGAC04.PLT By: STAN KLINE 10-26-04 12:12am



Factors Of Safety Calculated By The Modified Bishop Method

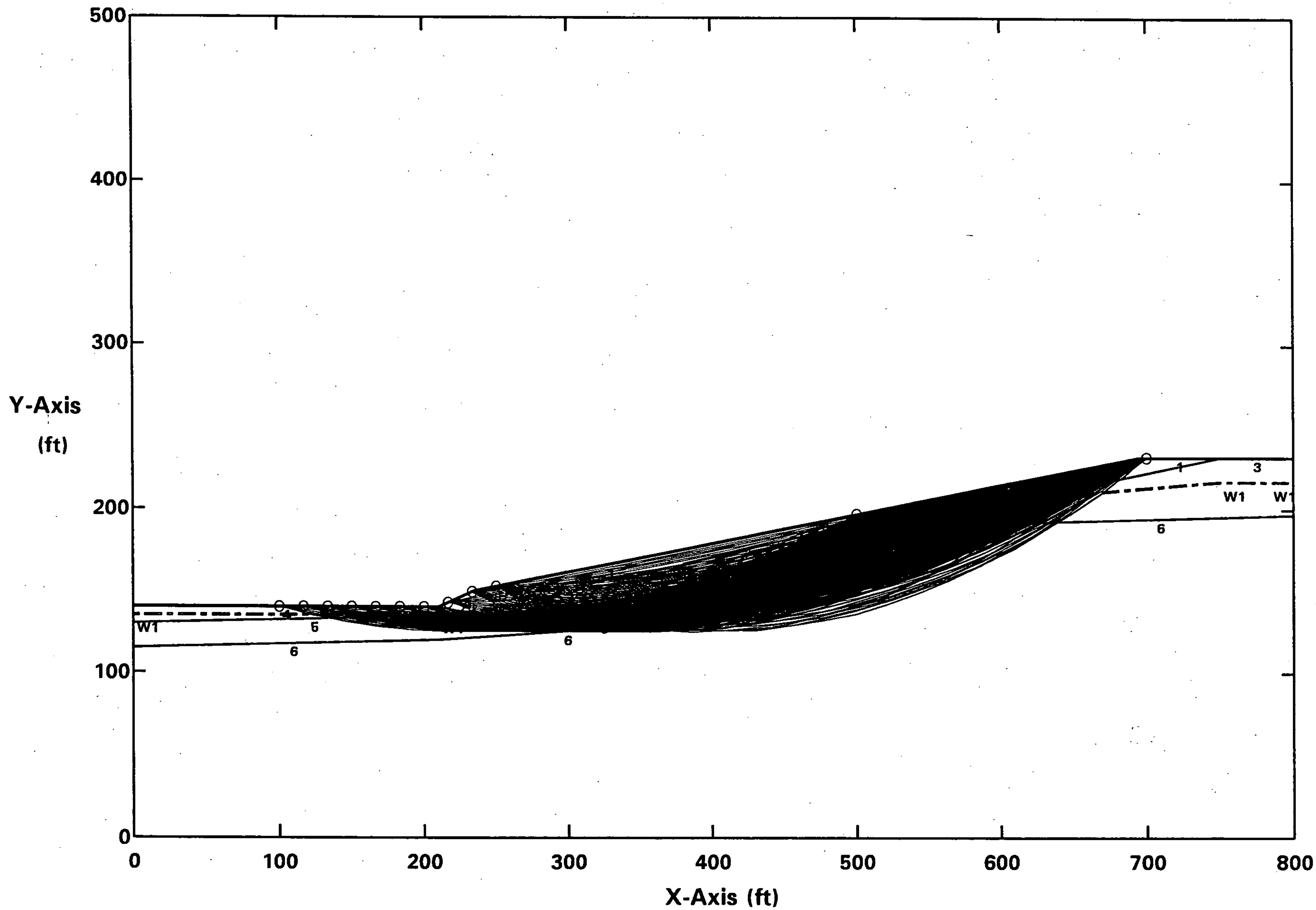
ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:CGAC06.PLT By: STAN KLINE 10-26-04 12:12am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

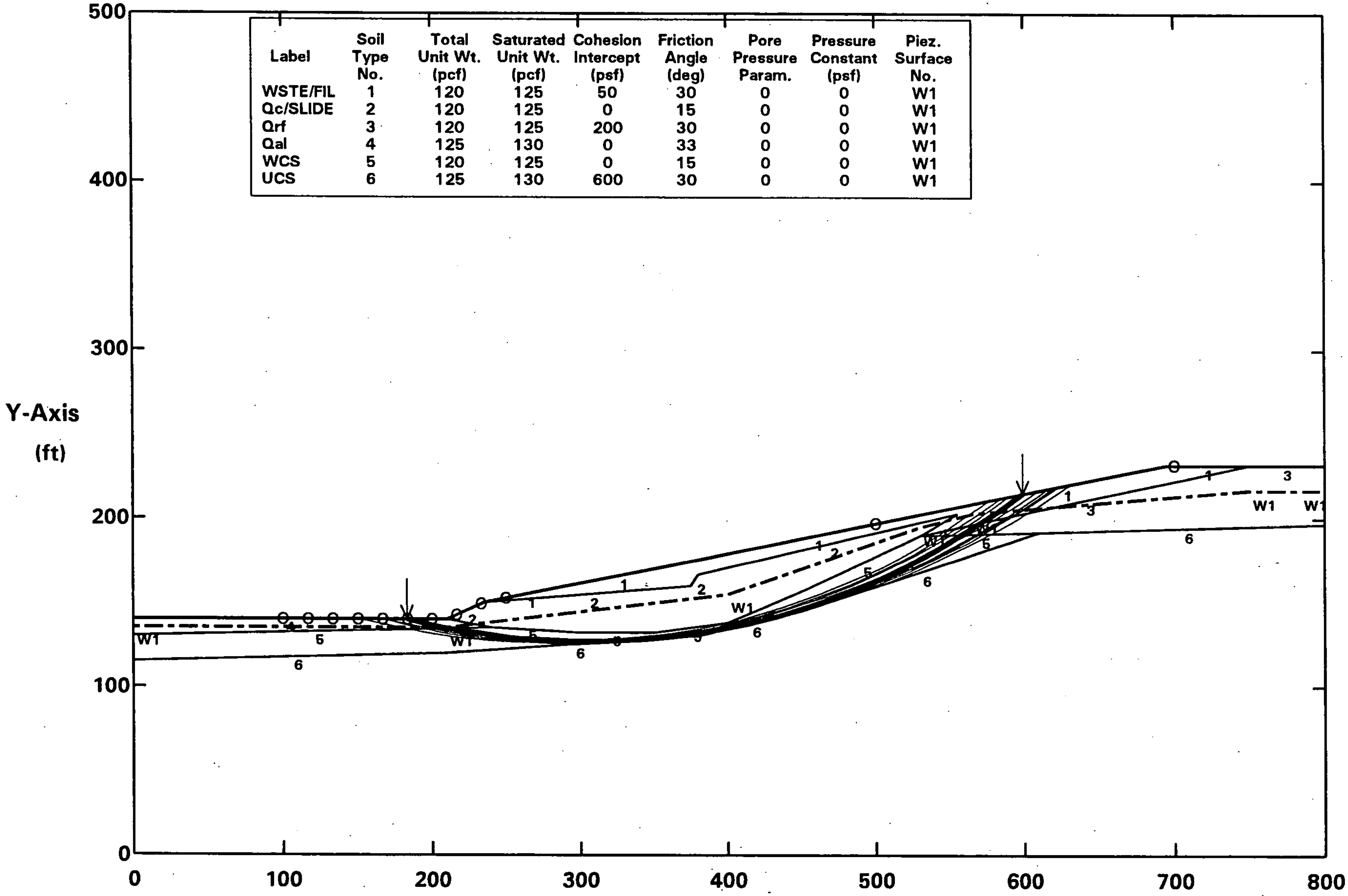
PCSTABL5M/SI FSmin = 0.93 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
All surfaces evaluated. C:CGHC06.PLT By: STAN KLINE 10-26-04 12:17am



Factors Of Safety Calculated By The Modified Bishop Method

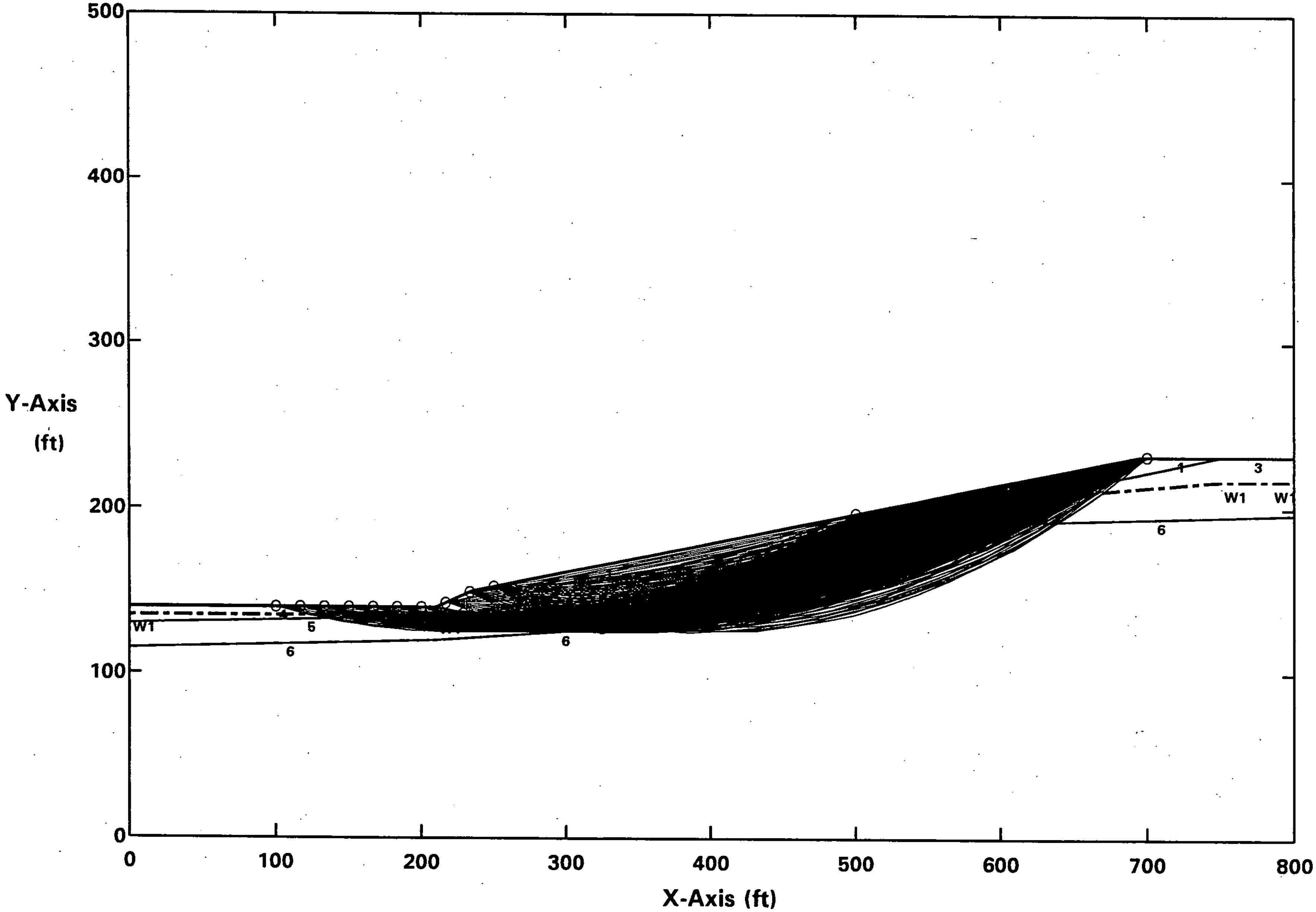
ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:CGHC06.PLT By: STAN KLINE 10-26-04 12:17am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

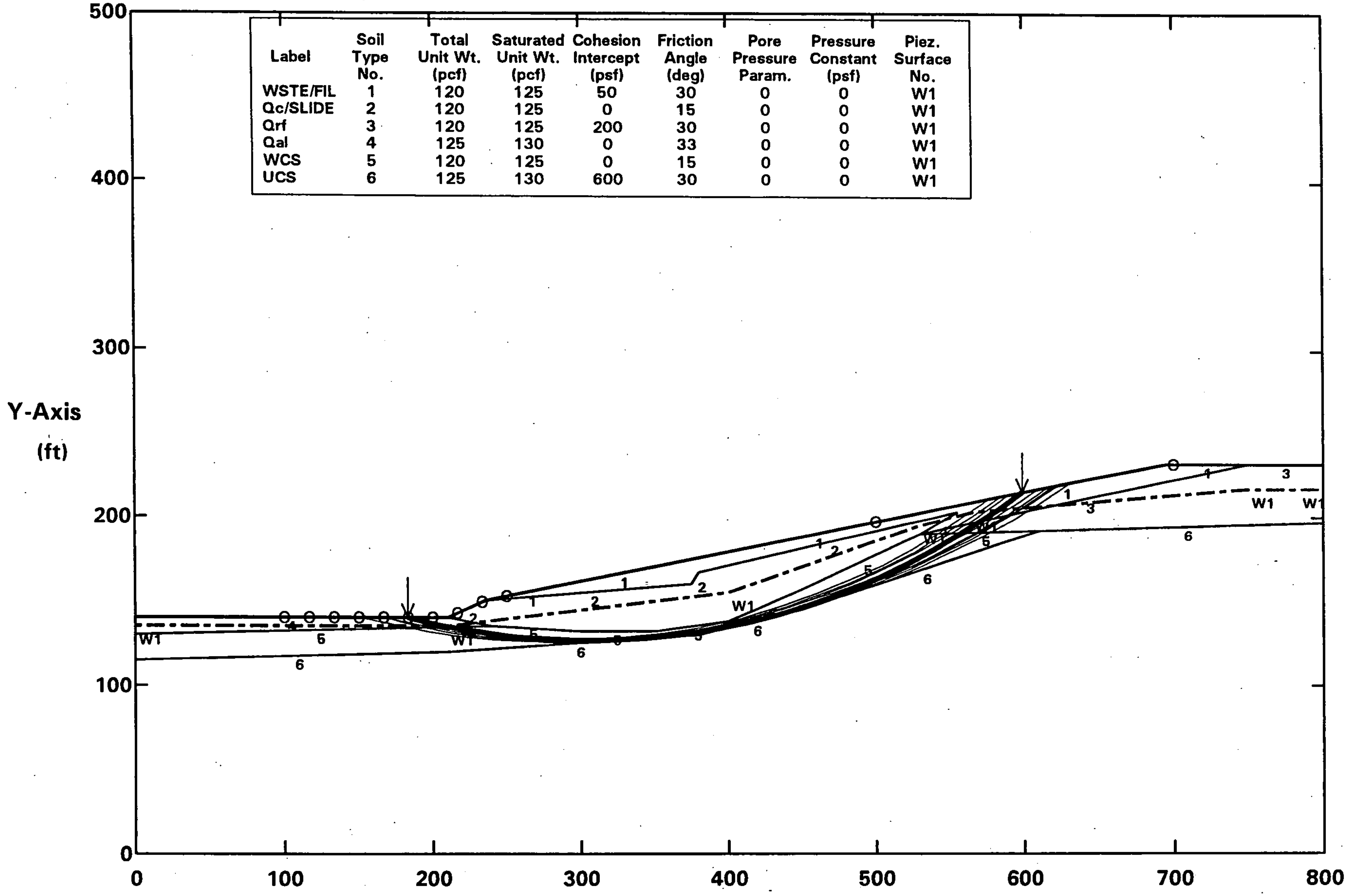
PCSTABL5M/SI FSmin = 0.90 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.03g
All surfaces evaluated. C:CGHC03.PLT By: STAN KLINE 10-26-04 12:16am



Factors Of Safety Calculated By The Modified Bishop Method

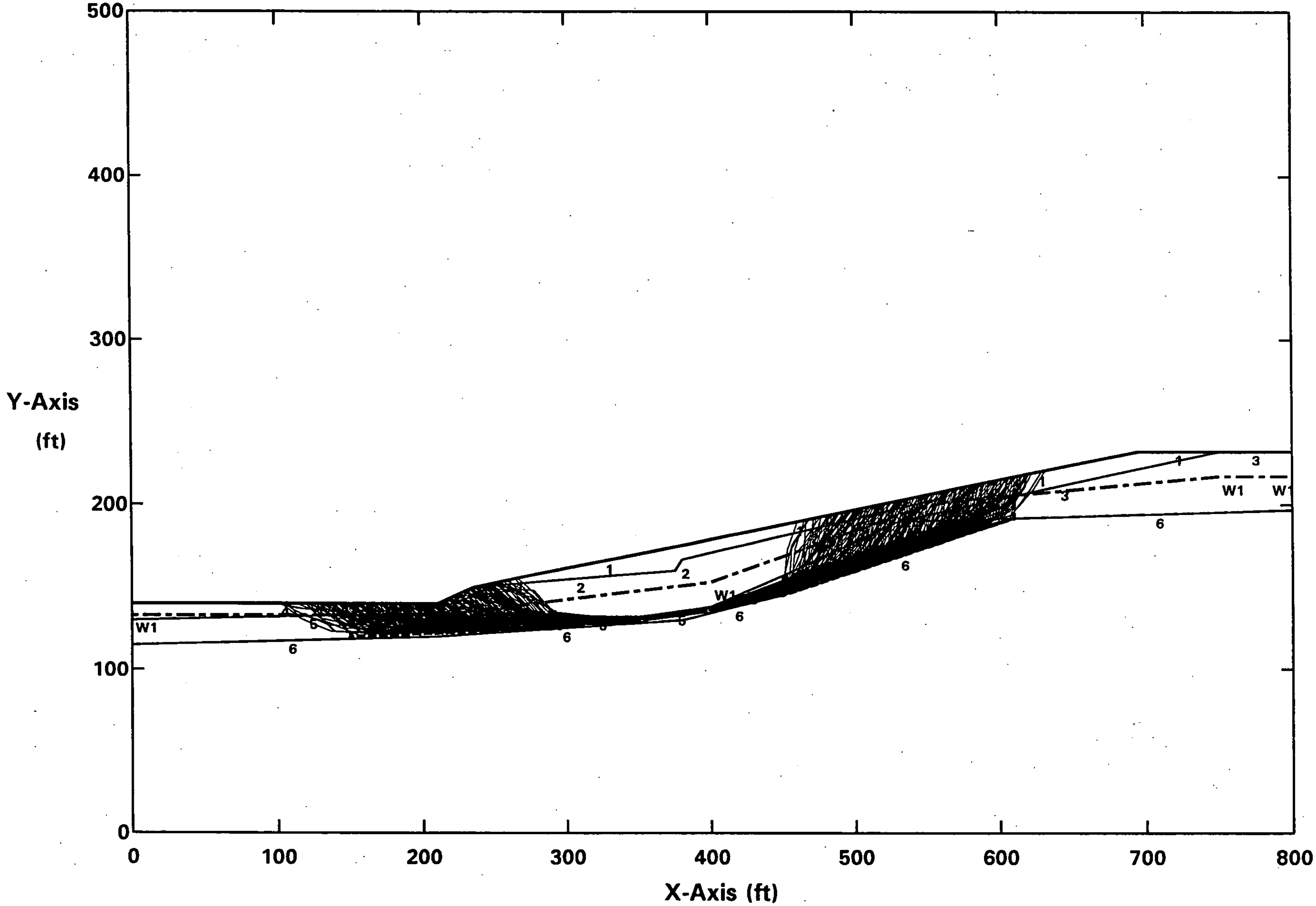
ROCKY FLATS OLF - M&E C 18% GRD - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.03g
Ten Most Critical. C:CGHC03.PLT By: STAN KLINE 10-26-04 12:16am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin=1.04 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

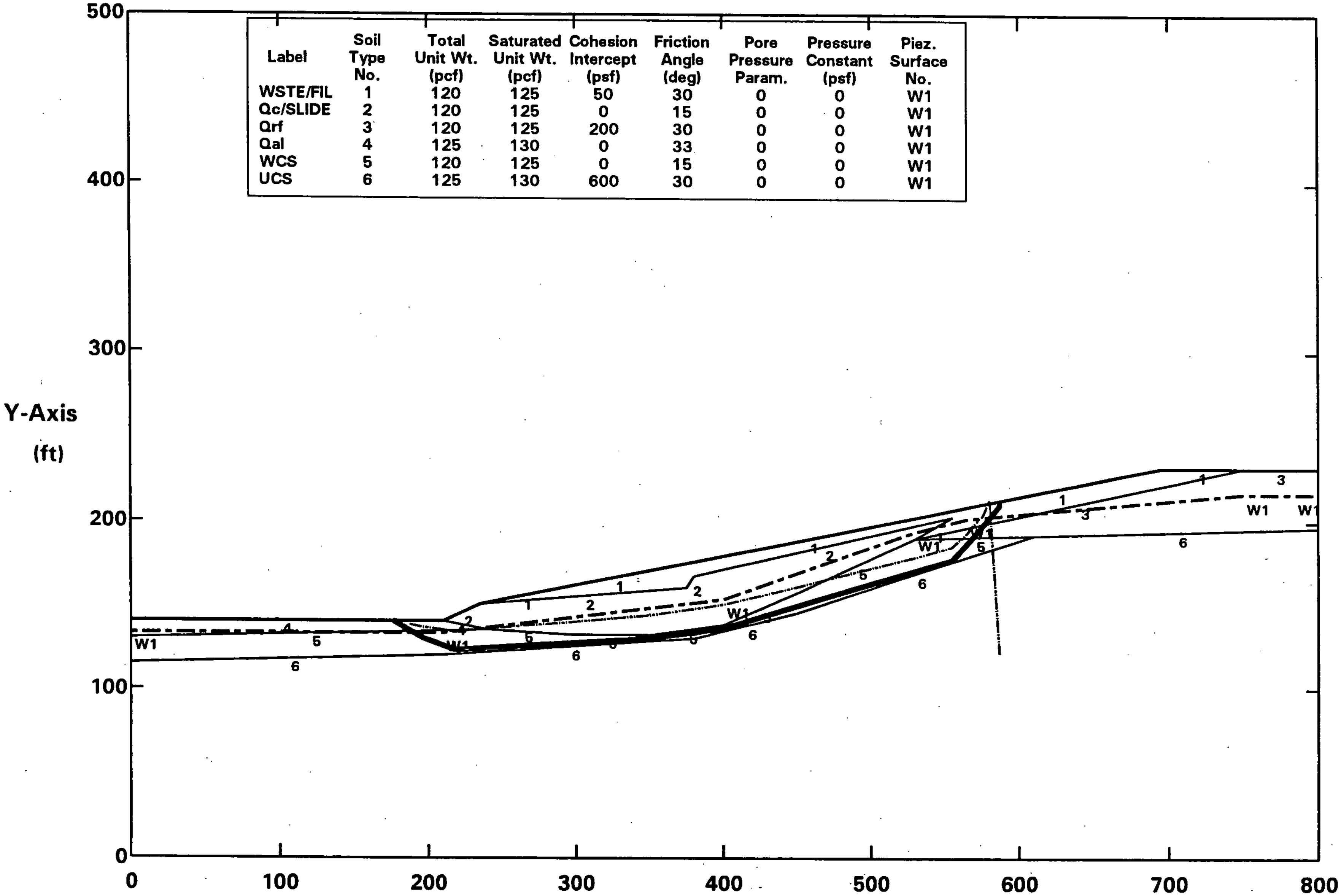
ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:CGAS06.PLT By: STAN KLINE 10-24-04 7:01pm



Factors Of Safety Calculated By The Modified Janbu Method

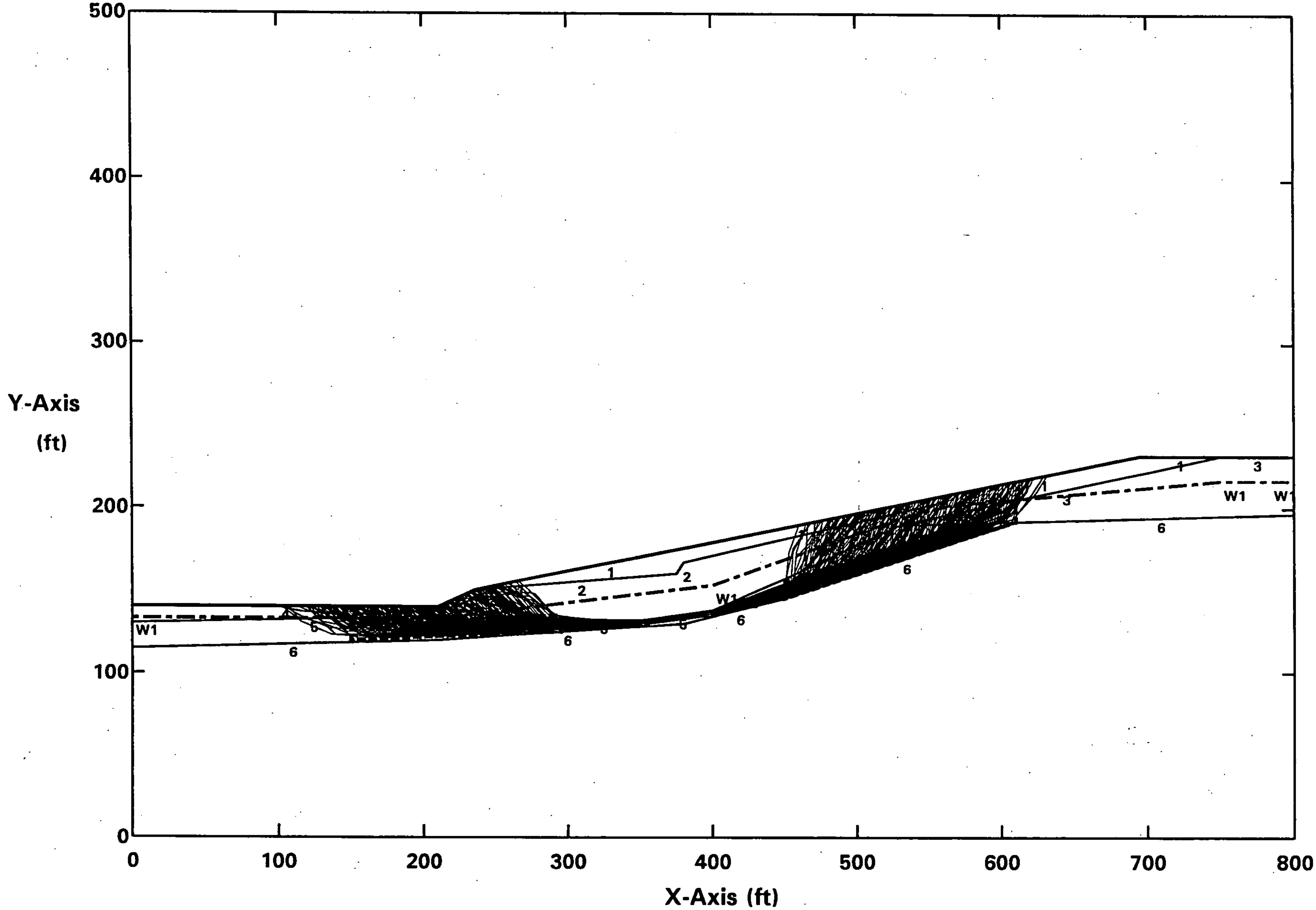
ROCKY FLATS OLF - M&E C 18% GRD - WCS=15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-CGAS06.OUT. C:CGAS06SP.PLT By: STAN KLINE 10-24-04 7:03pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



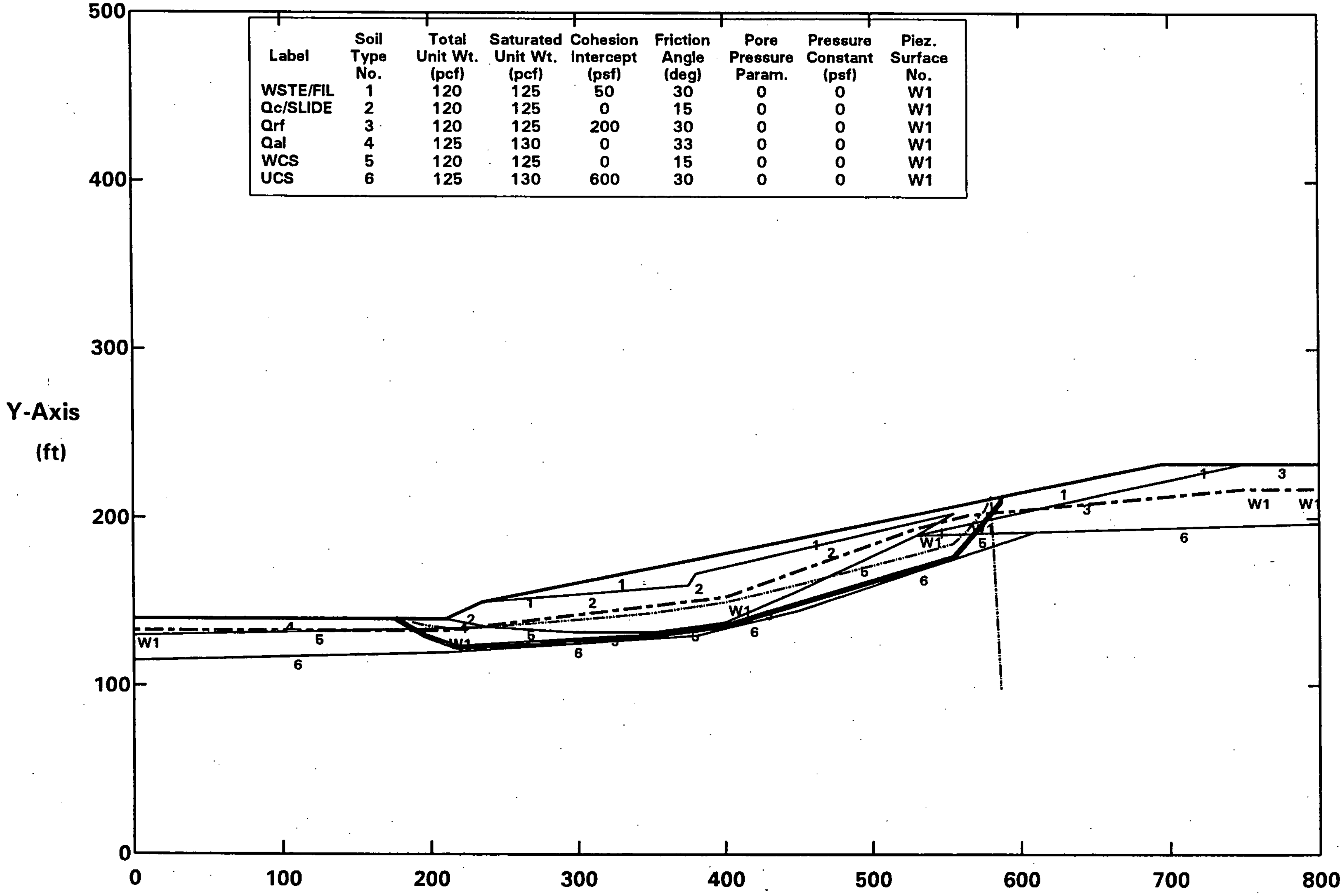
PCSTABL5M/SI FS=0.91 Theta=8.85 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.04g
All surfaces evaluated. C:CGAS04.PLT By: STAN KLINE 10-24-04 6:58pm



Factors Of Safety Calculated By The Modified Janbu Method

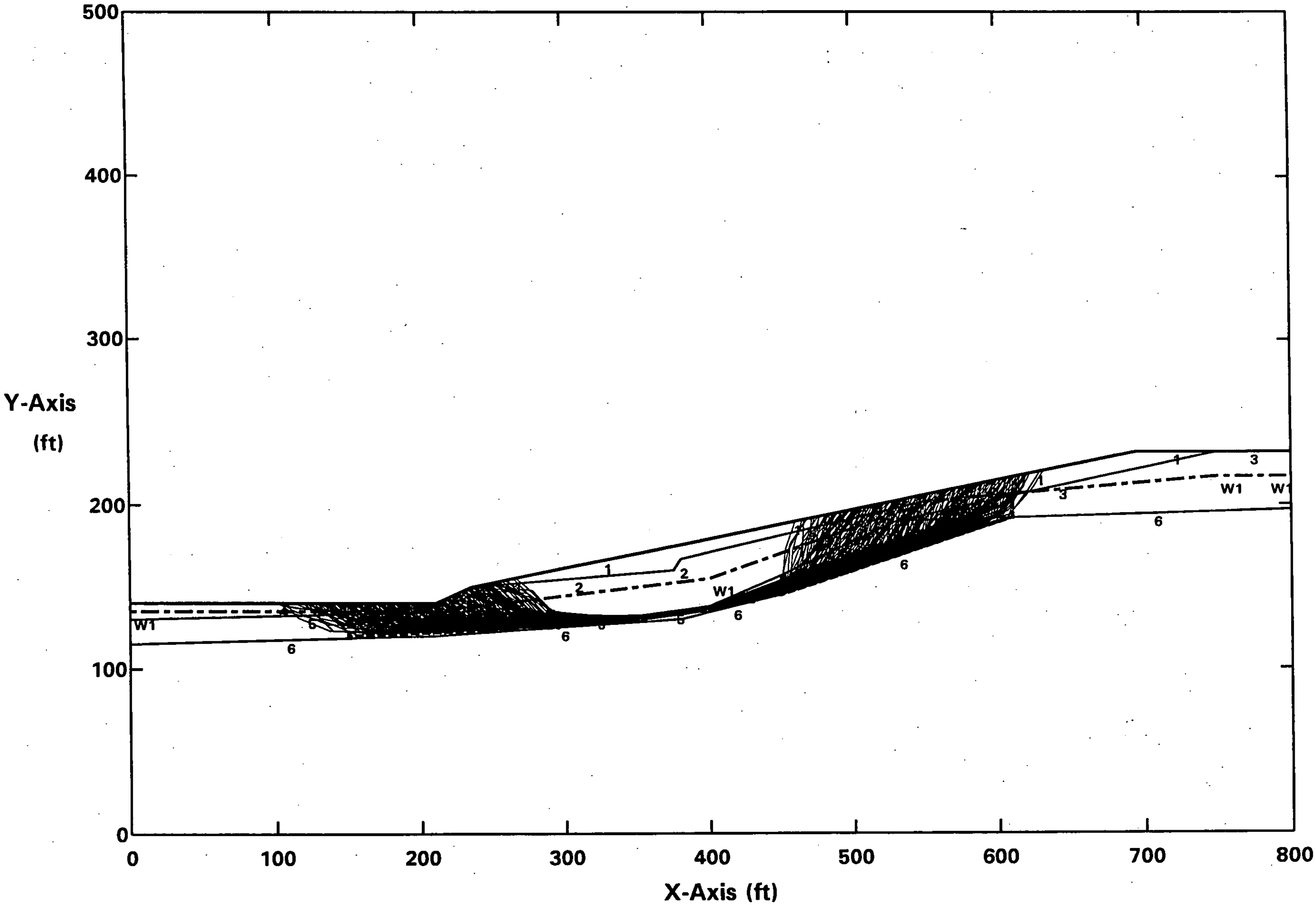
ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.04g
Surface #1-CGAS04.OUT. C:CGAS04SP.PLT By: STAN KLINE 10-24-04 7:00pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS = 1.00 Theta = 8.96 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

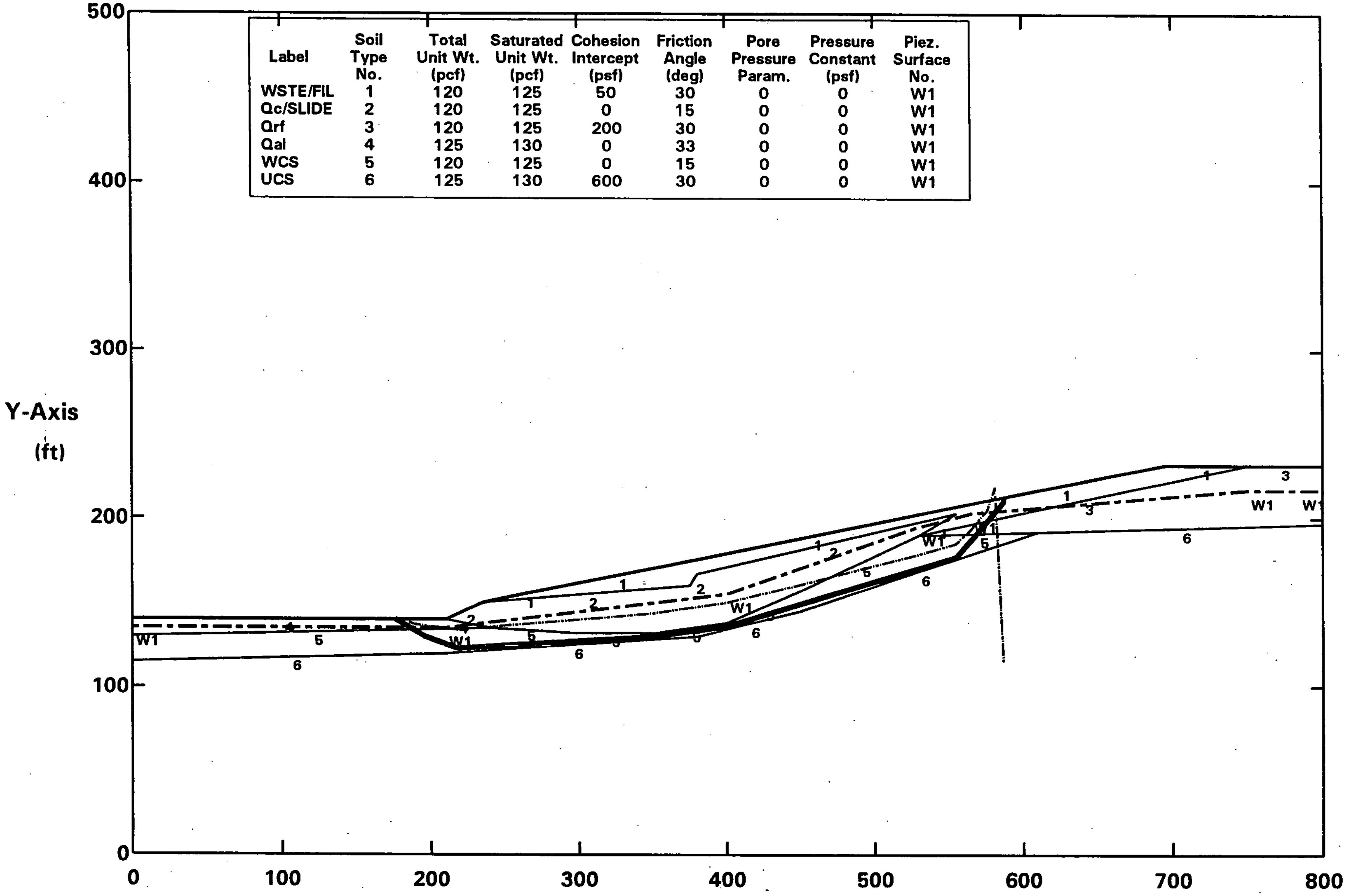
ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:CGHS06.PLT By: STAN KLINE 10-24-04 7:23pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-CGHS06.OUT. C:CGHS06SP.PLT By: STAN KLINE 10-24-04 7:24pm

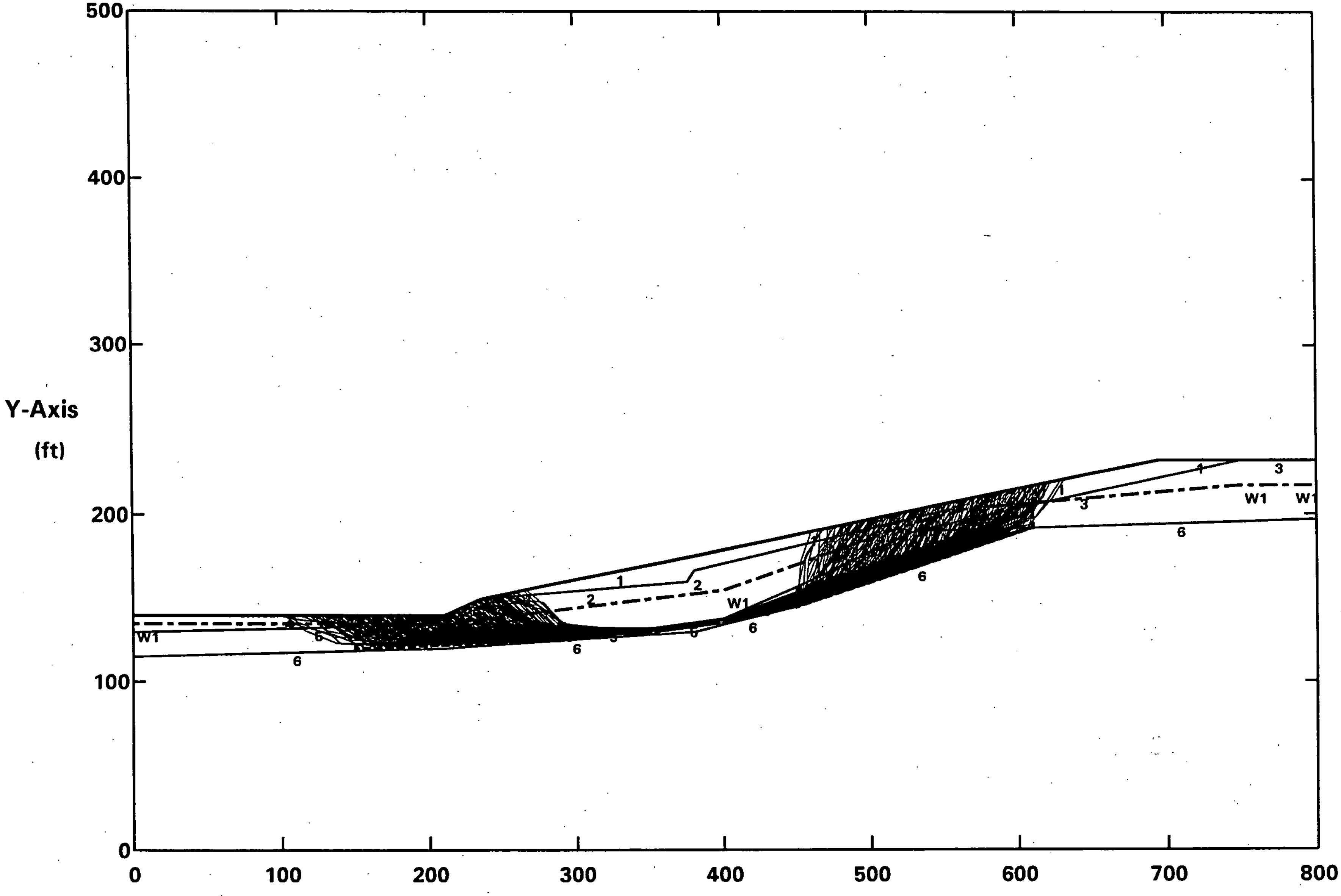
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS = 0.88 Theta = 8.87 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

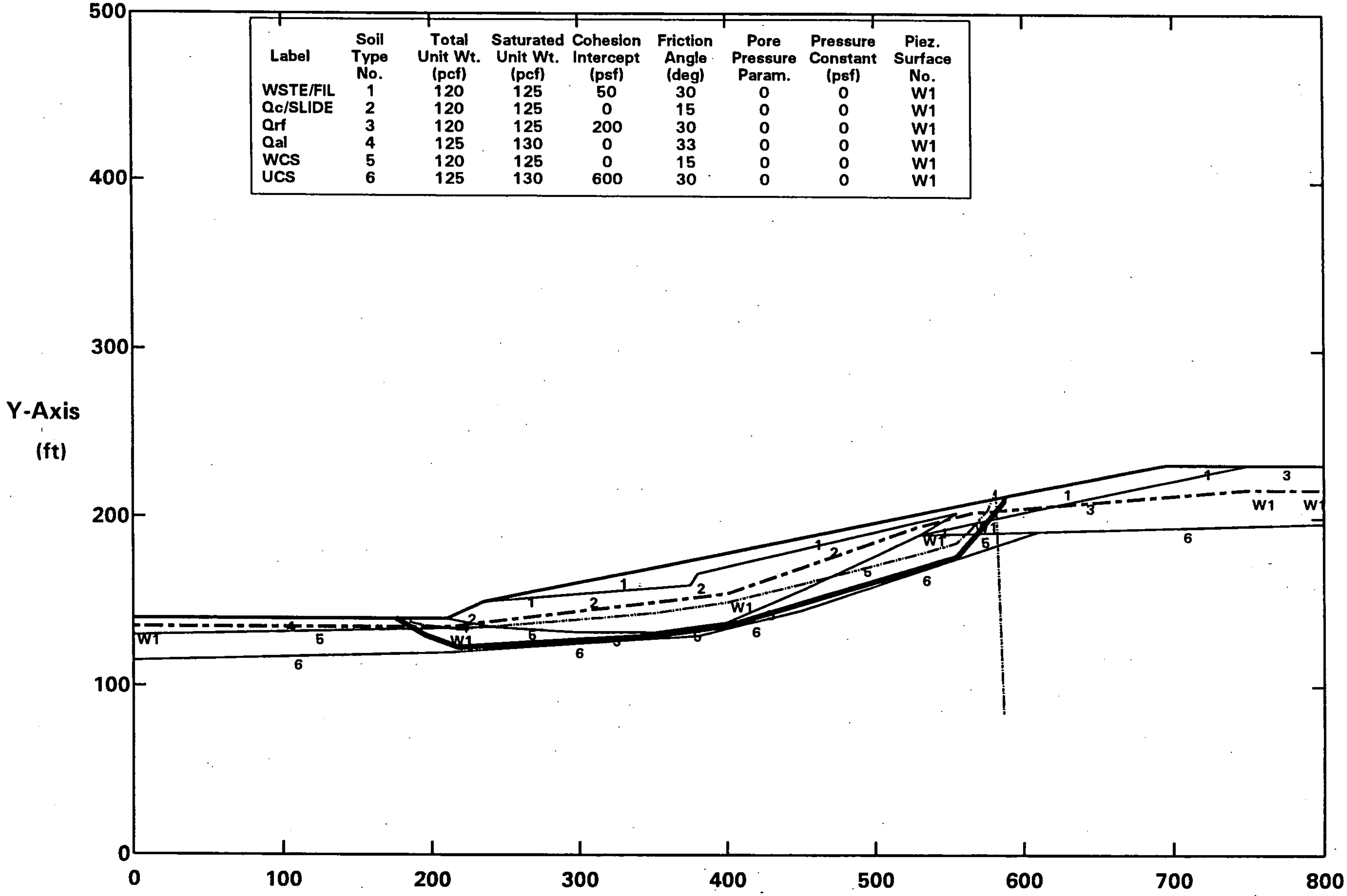
ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.03g

All surfaces evaluated. C:CGHS03.PLT By: STAN KLINE 10-24-04 7:20pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E C 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.03g
Surface #1-CGHS03.OUT. C:CGHS03SP.PLT By: STAN KLINE 10-24-04 7:22pm

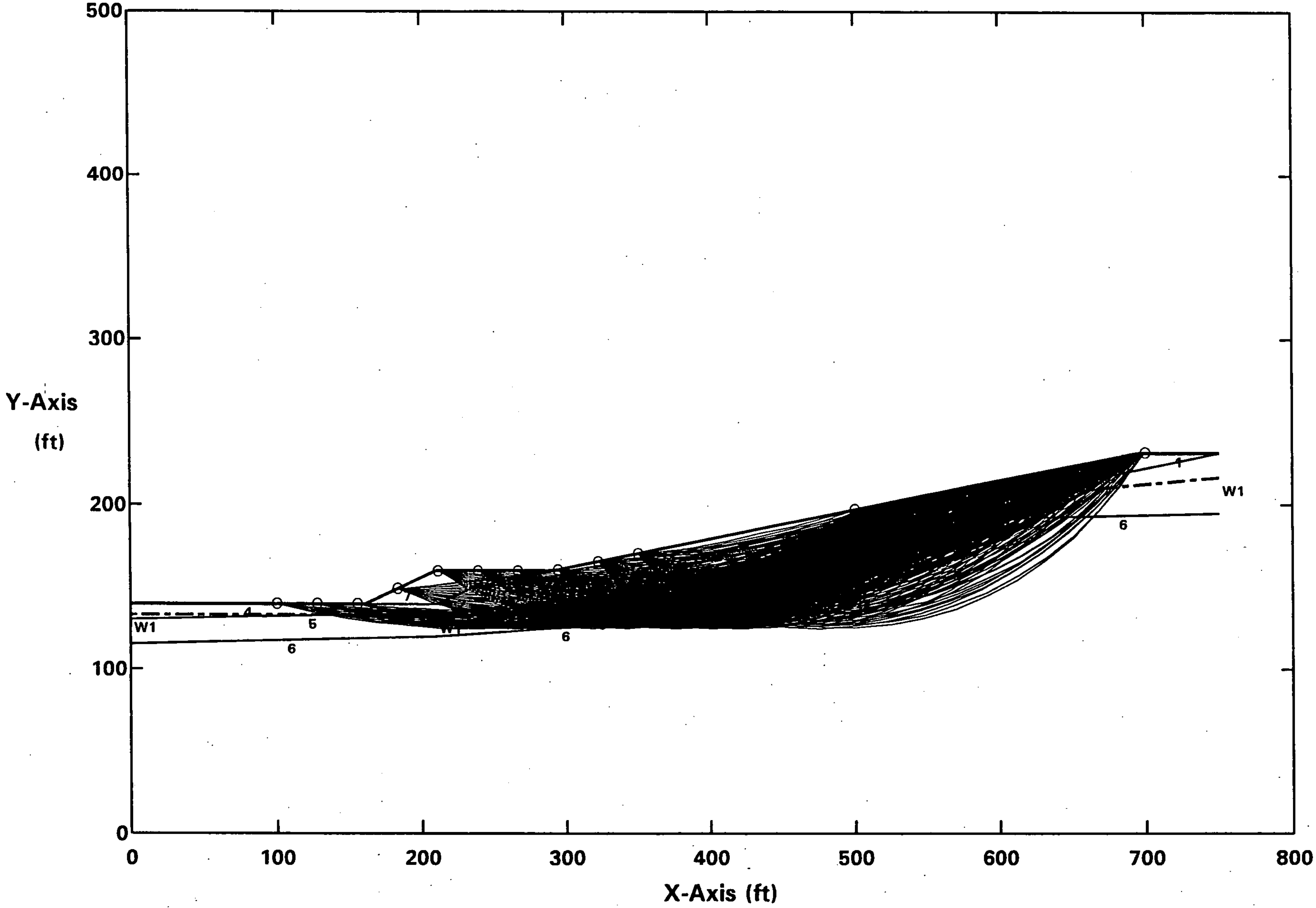


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS = 1.01 Theta = 9.05 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

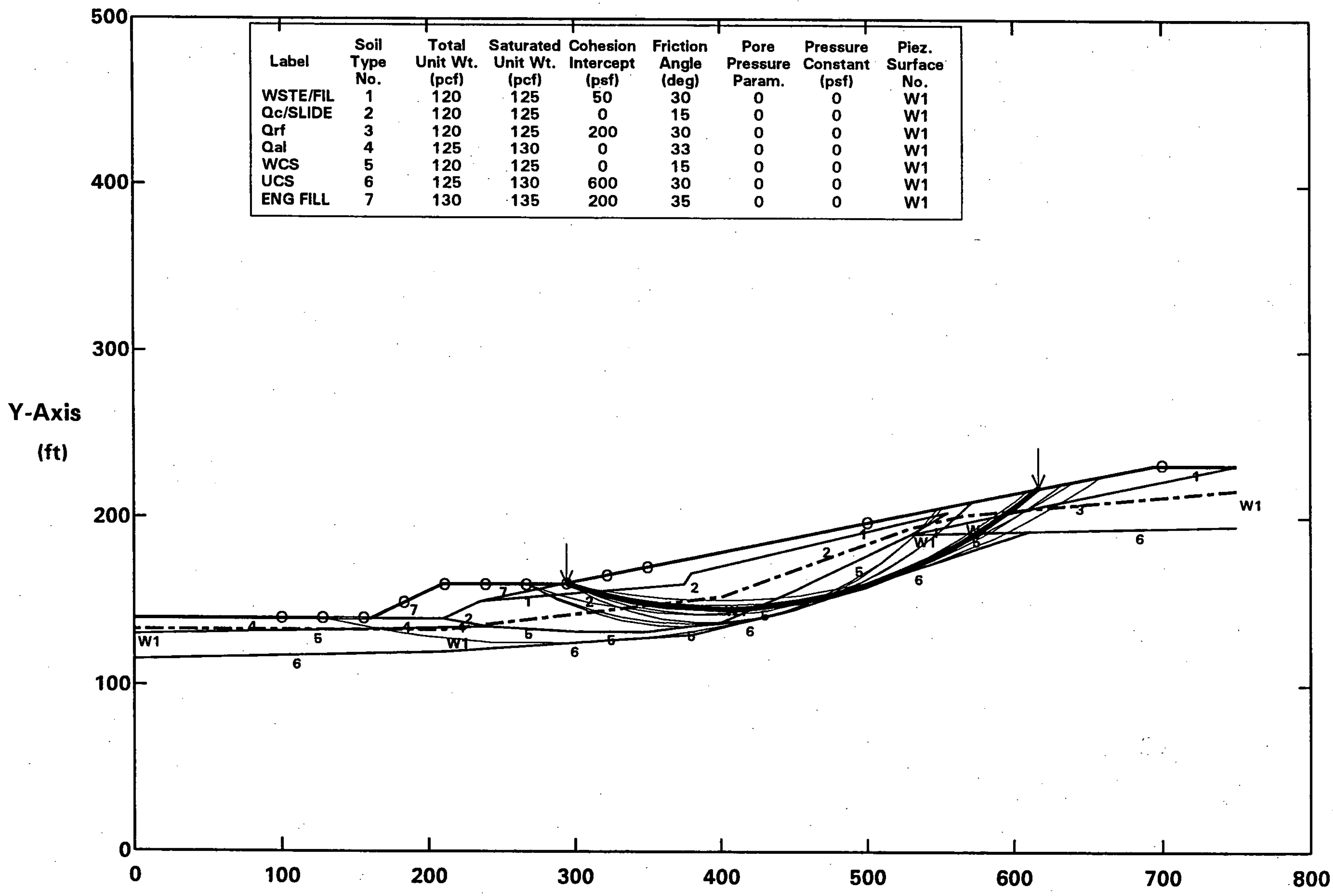
18% REGRADE WITH BUTTRESS CONDITION

ROCKY FLATS OLF - M&E C 18%W/BM - WCS=15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:CBAC06.PLT By: STAN KLINE 10-26-04 12:13am



Factors Of Safety Calculated By The Modified Bishop Method

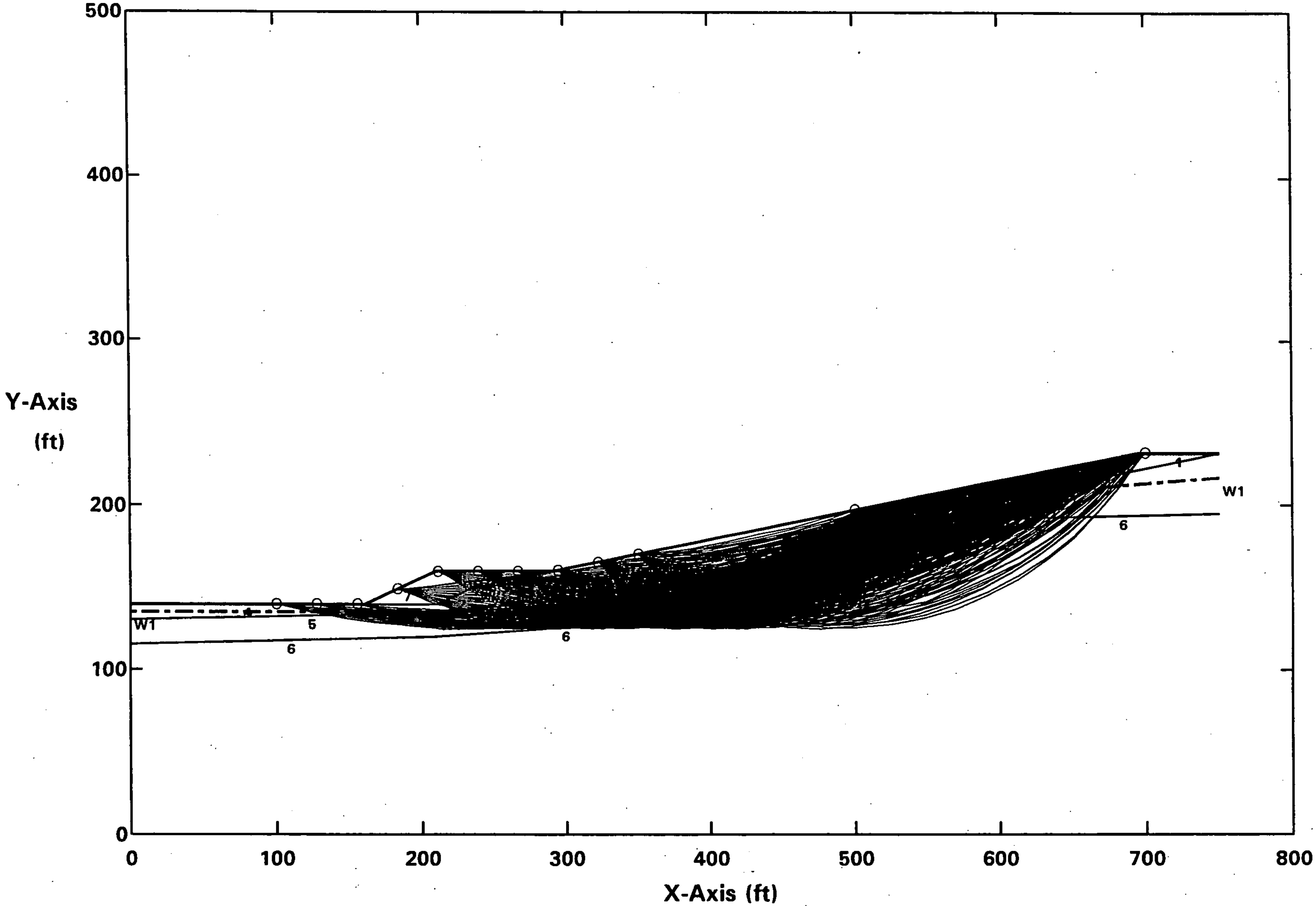
ROCKY FLATS OLF - M&E C 18%W/BM - WCS=15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:CBAC06.PLT By: STAN KLINE 10-26-04 12:13am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

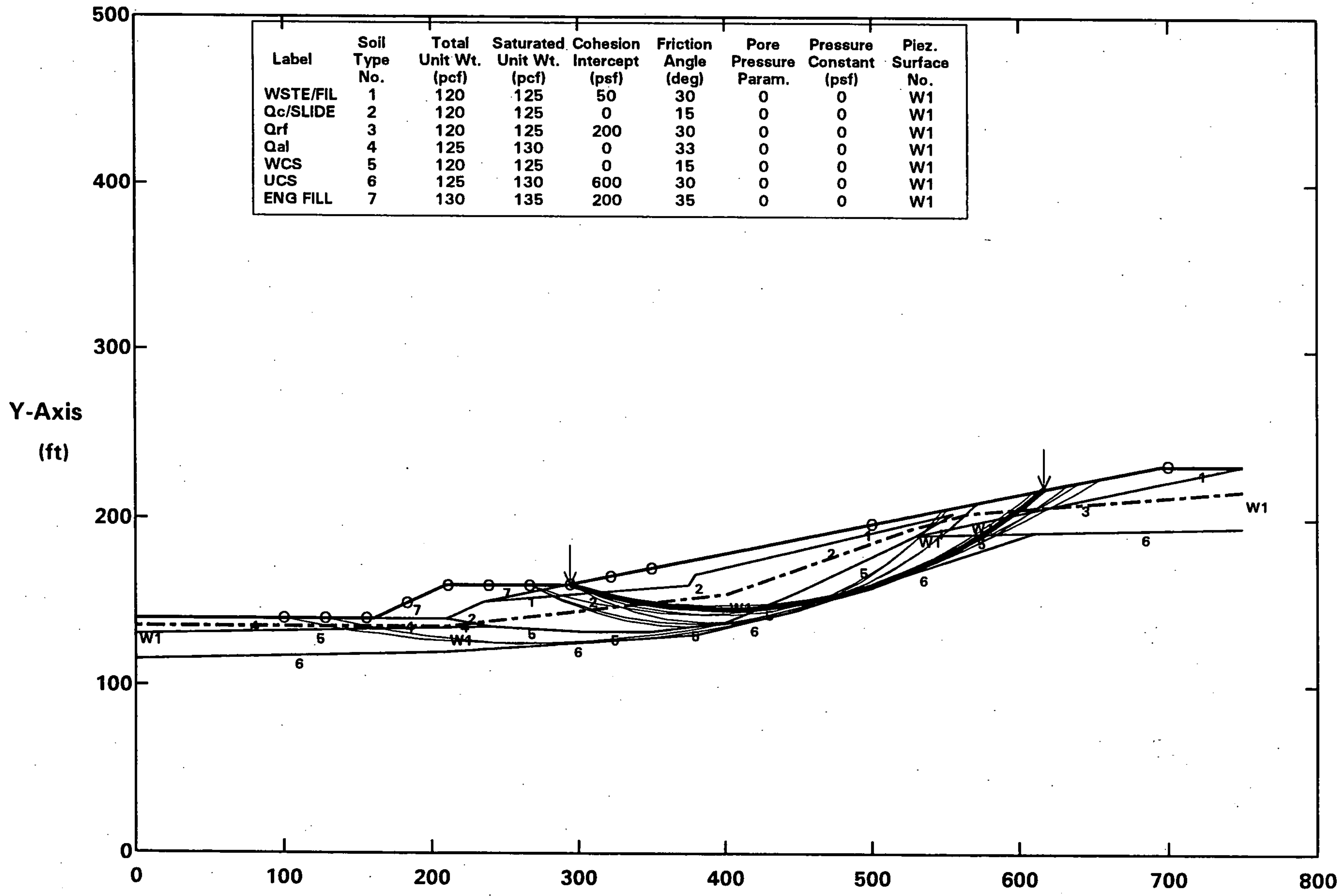
PCSTABL5M/SI FSmin=1.03 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
All surfaces evaluated. C:CBHC06.PLT By: STAN KLINE 10-26-04 12:17am



Factors Of Safety Calculated By The Modified Bishop Method

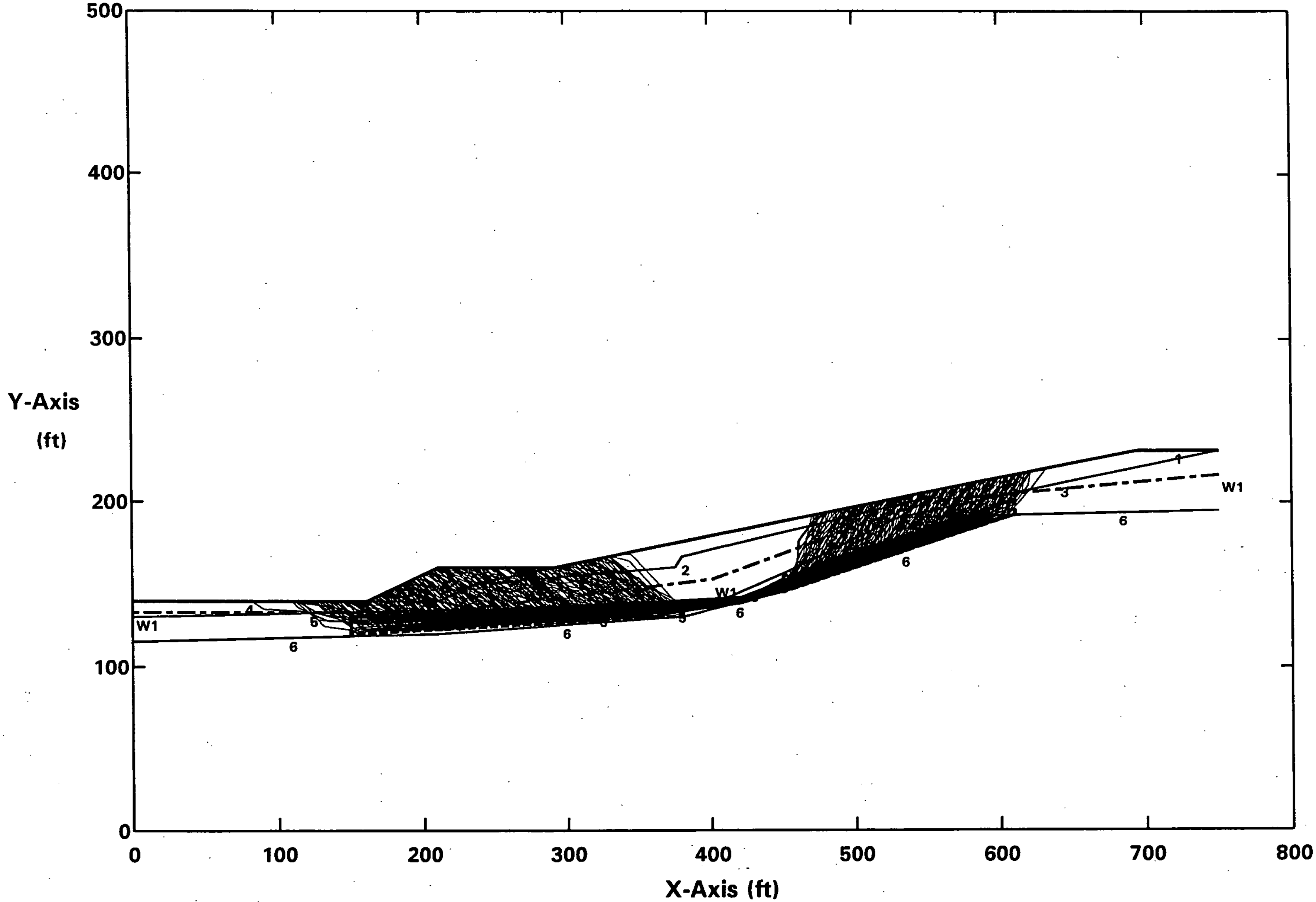
ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:CBHC06.PLT By: STAN KLINE 10-26-04 12:17am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

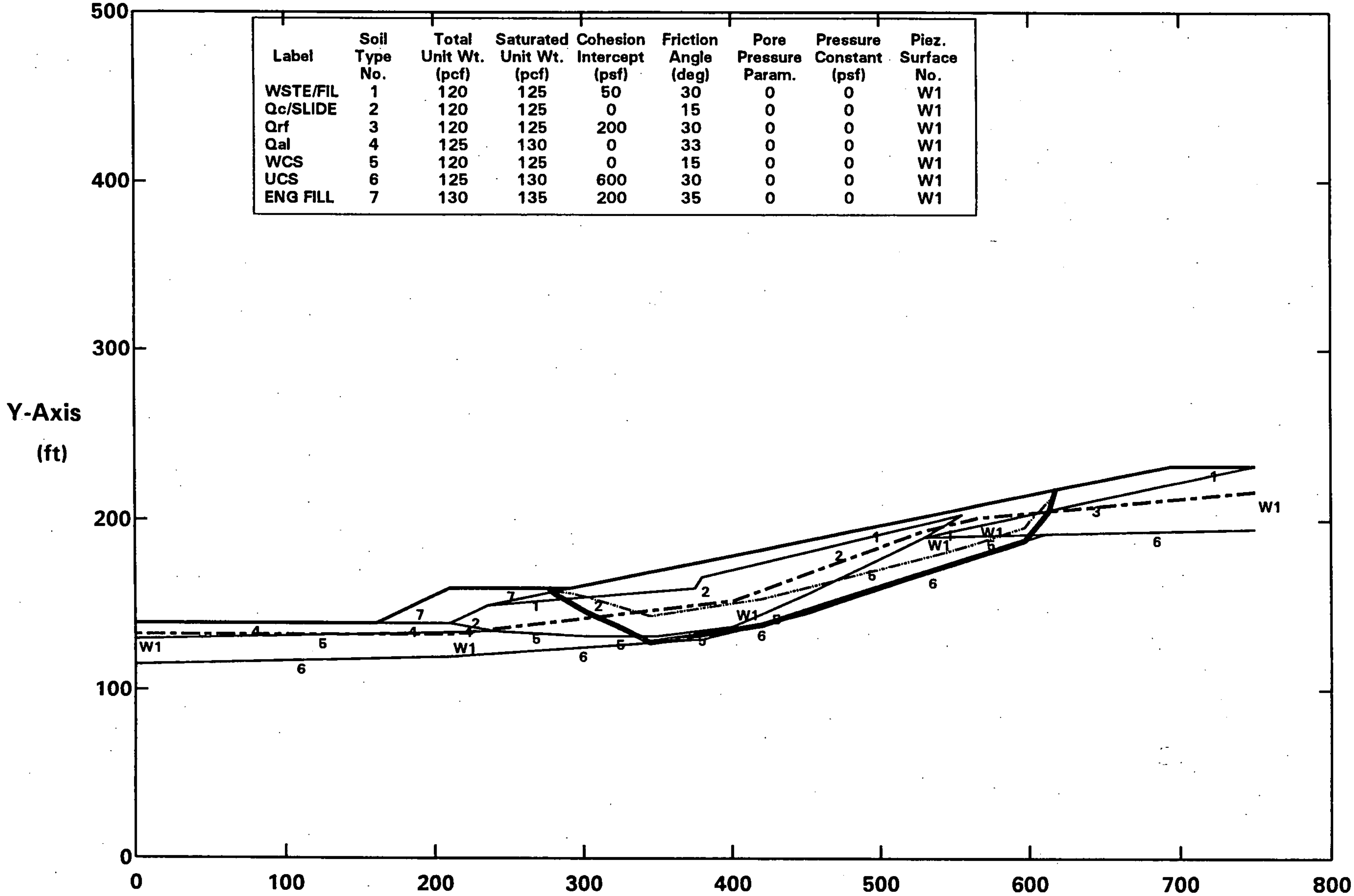
PCSTABL5M/SI FSmin = 1.01 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:CBAS06.PLT By: STAN KLINE 10-24-04 7:05pm



Factors Of Safety Calculated By The Modified Janbu Method

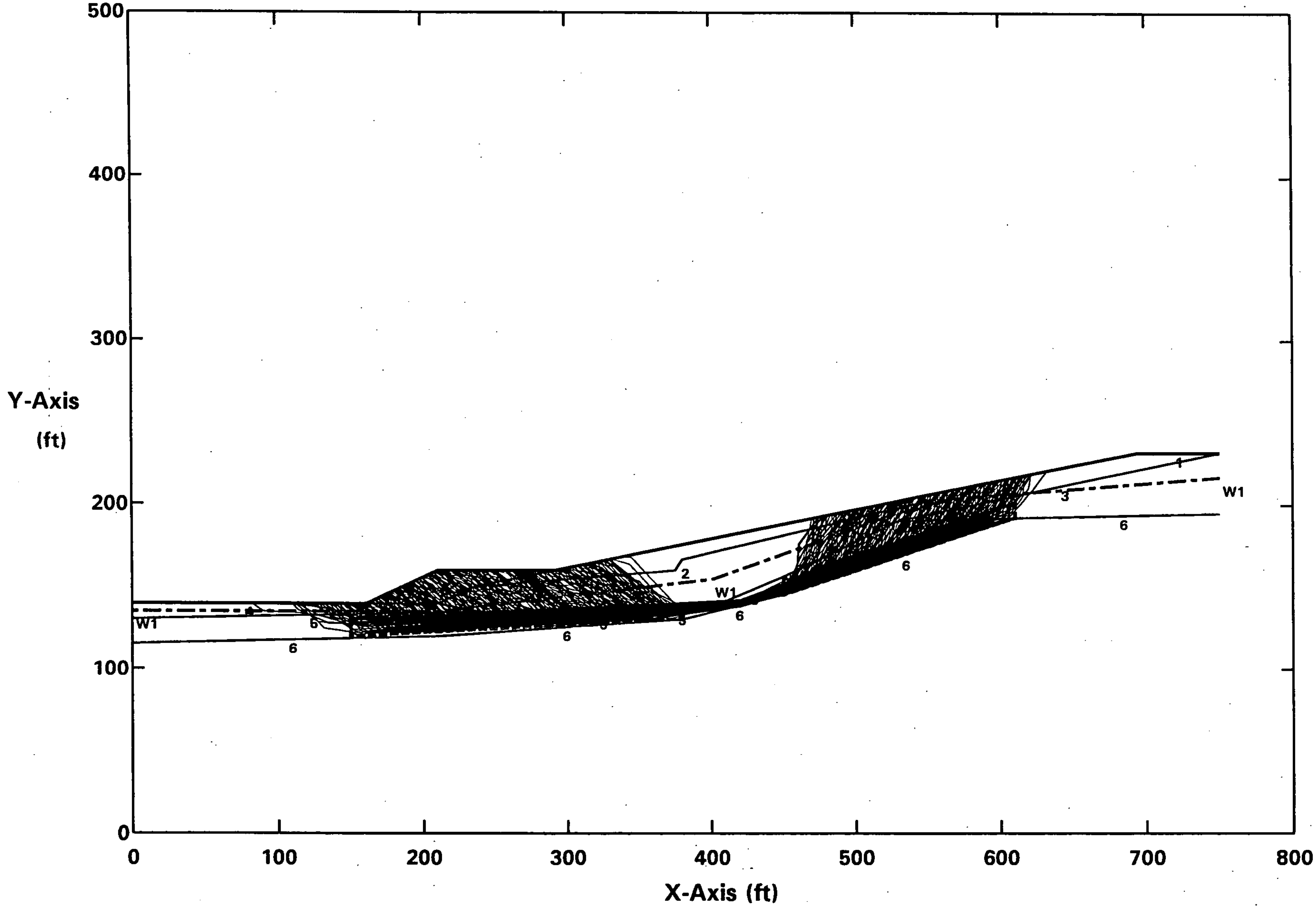
ROCKY FLATS OLF - M&E C 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-CBAS06.OUT. C:CBAS06SP.PLT By: STAN KLINE 10-24-04 7:08pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

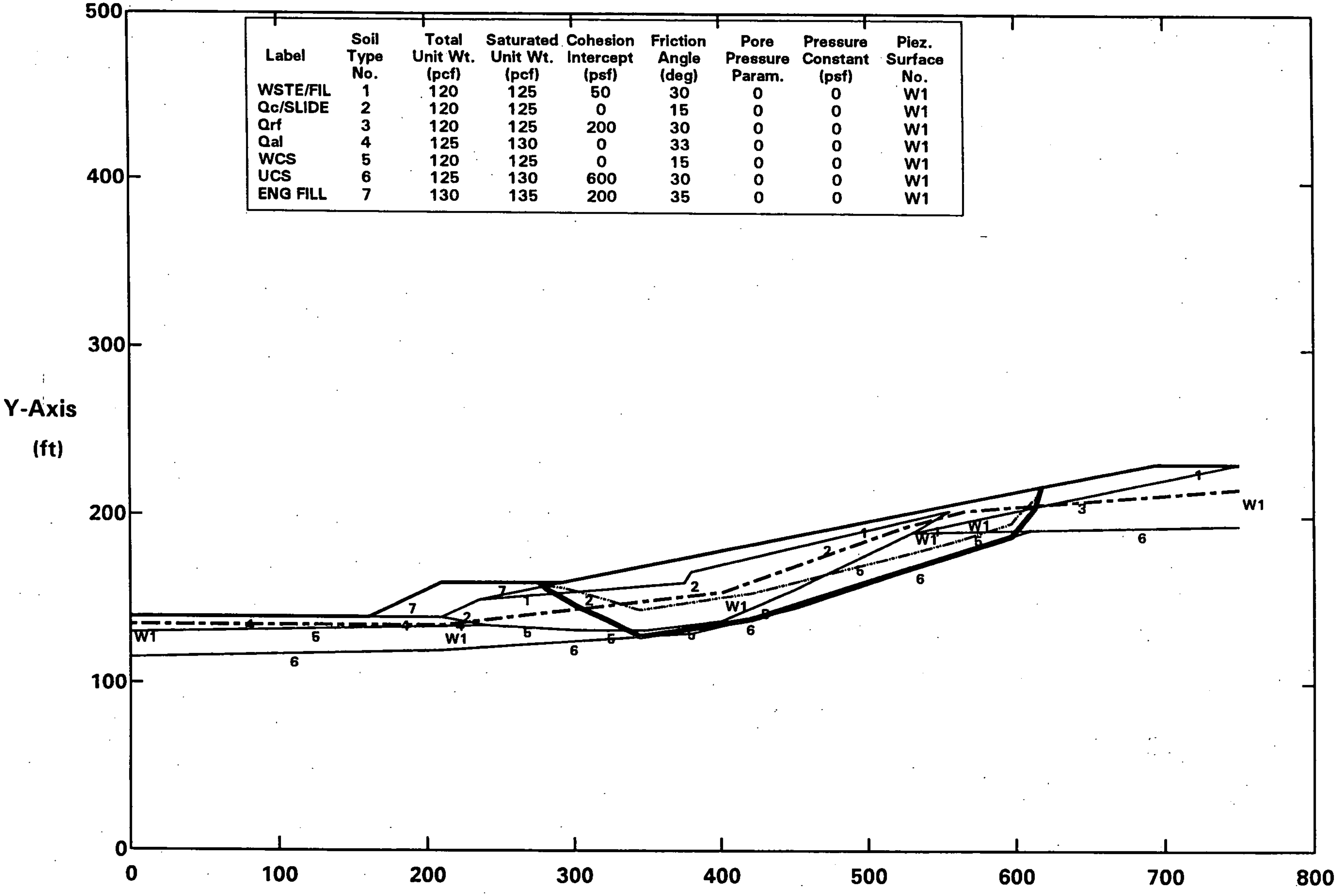
PCSTABL5M/SI FS = 1.03 Theta = 7.72 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E C 18%W/BM - WCS= 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:CBHS06.PLT By: STAN KLINE 10-24-04 7:26pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E C 18%W/BM - WCS=15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-CBHS06.OUT. C:CBHS06SP.PLT By: STAN KLINE 10-24-04 7:28pm



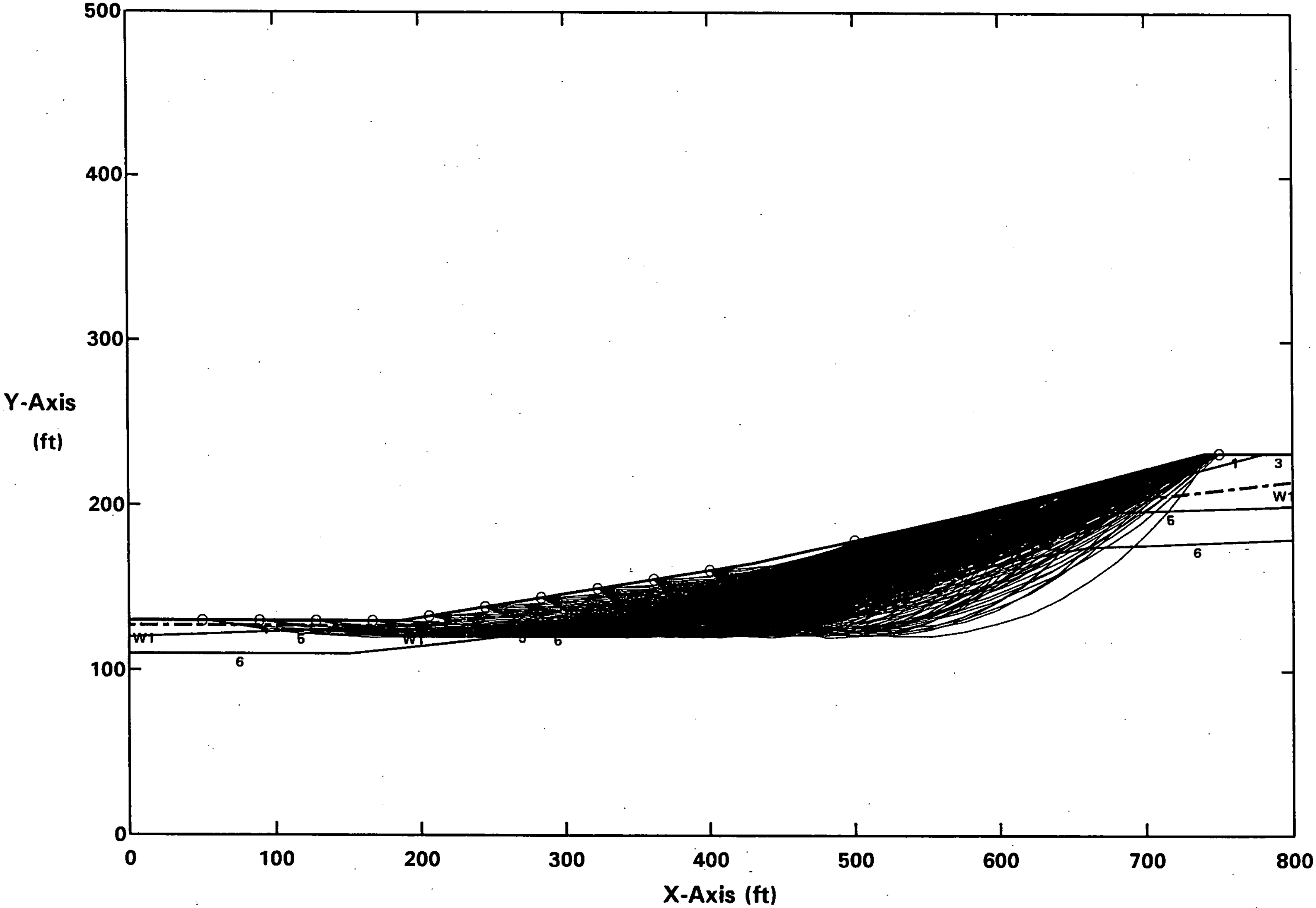
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FS=1.01 Theta=7.66 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

M&E SECTION D-D' – PSEUDOSTATIC

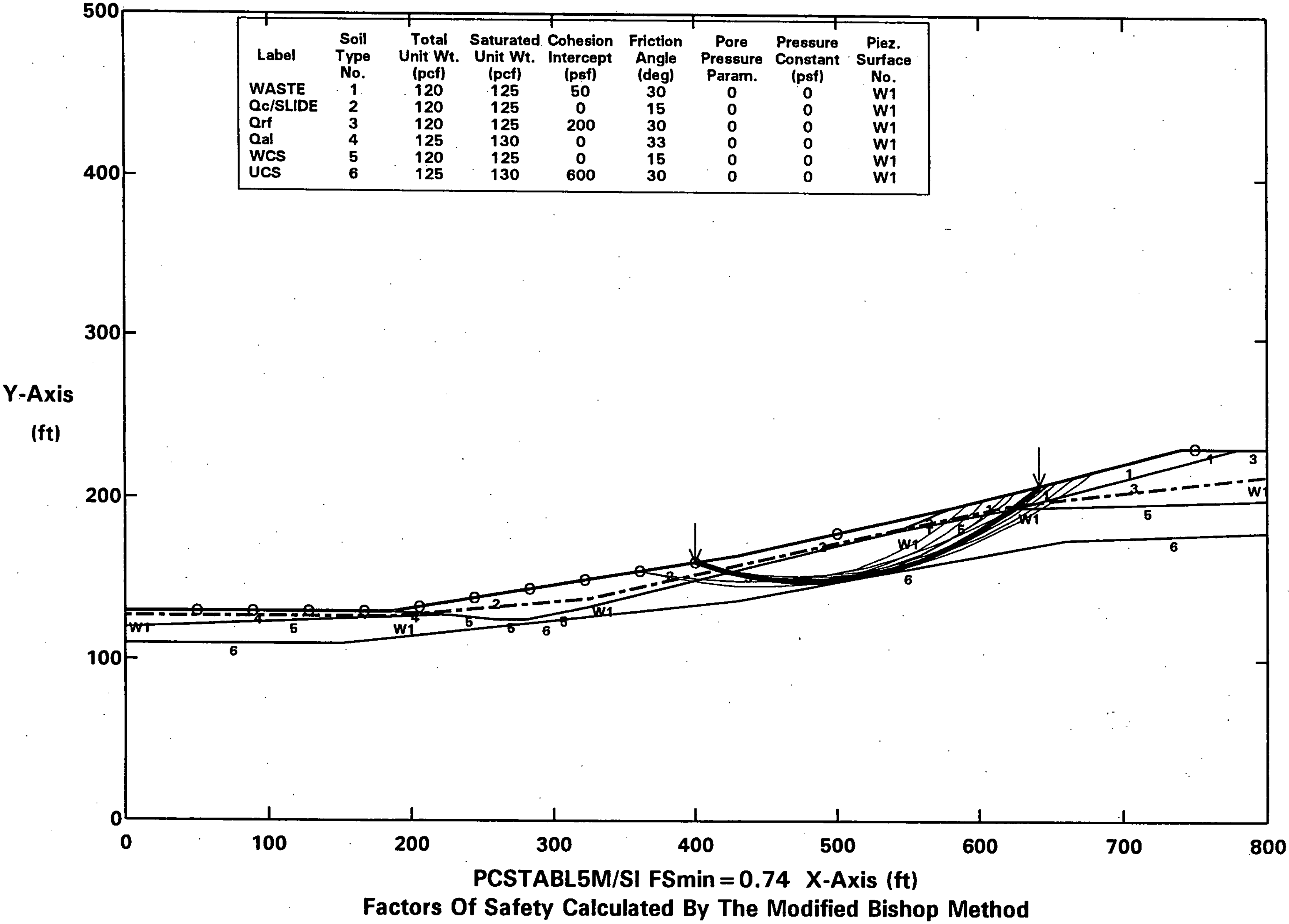
EXISTING CONDITIONS

ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:DEAC06.PLT By: STAN KLINE 10-26-04 12:20am



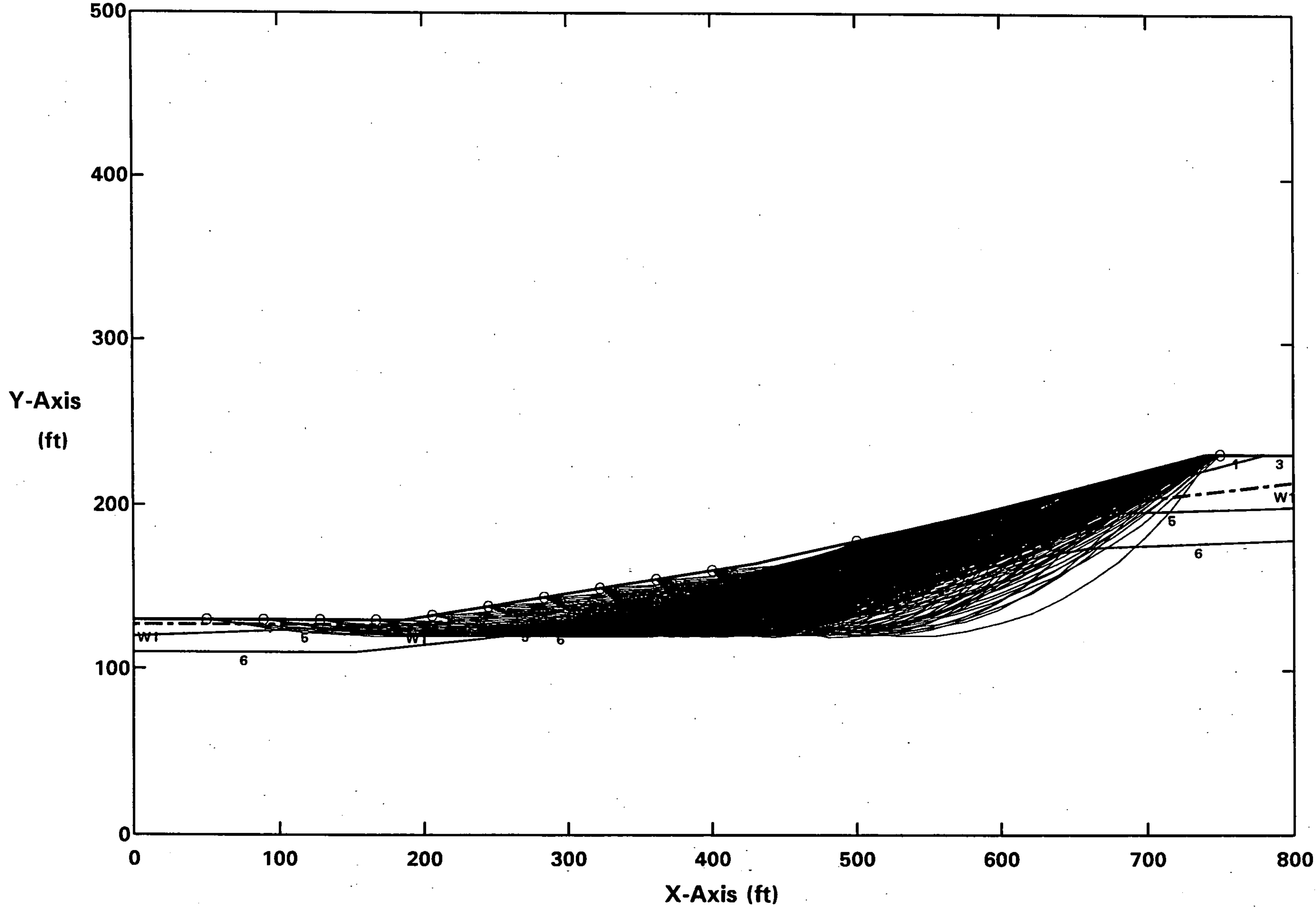
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:DEAC06.PLT By: STAN KLINE 10-26-04 12:20am



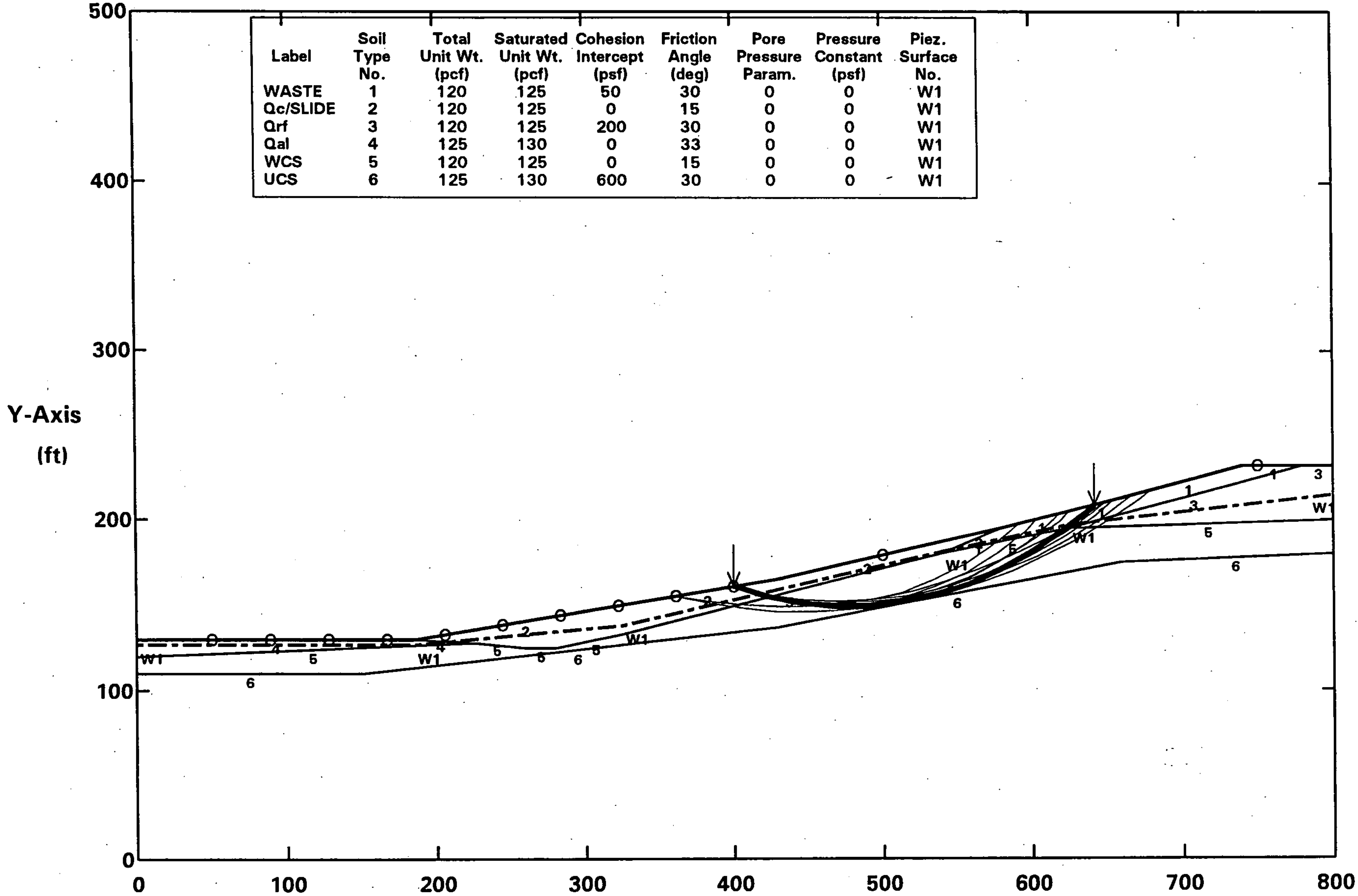
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

ROCKY FLATS OLF - M&E SECTION D - WCS=15deg - W/AVEGW - CIRCULAR - 0.00g(STATIC)
All surfaces evaluated. C:DEAC00.PLT By: STAN KLINE 10-26-04 12:19am



Factors Of Safety Calculated By The Modified Bishop Method

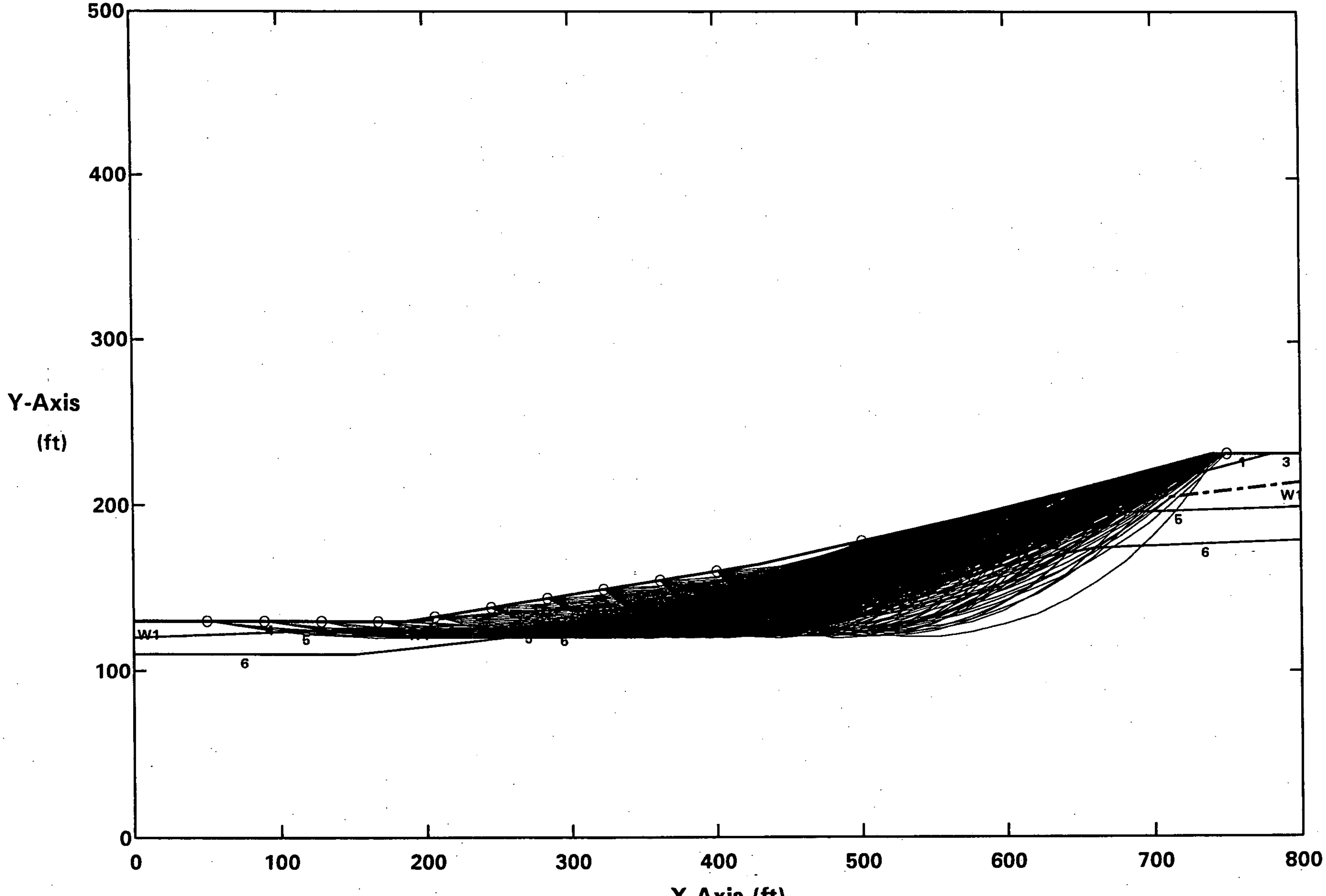
ROCKY FLATS OLF - M&E SECTION D - WCS = 15deg - W/AVEGW - CIRCULAR - 0.00g(STATIC)
Ten Most Critical. C:DEAC00.PLT By: STAN KLINE 10-26-04 12:19am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

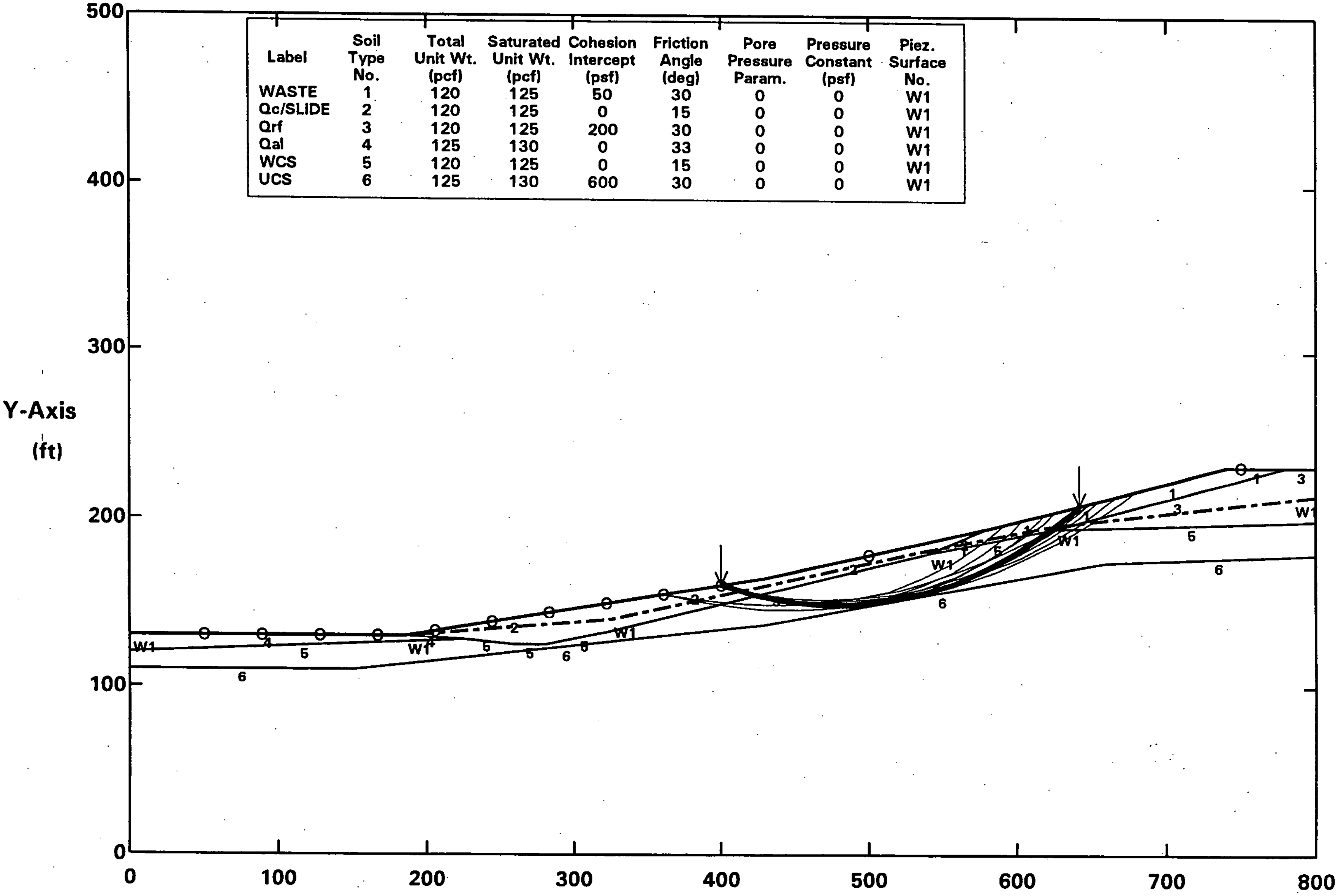
PCSTABL5M/SI FSmin = 0.97 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
All surfaces evaluated. C:DEHC06.PLT By: STAN KLINE 10-26-04 12:25am



Factors Of Safety Calculated By The Modified Bishop Method

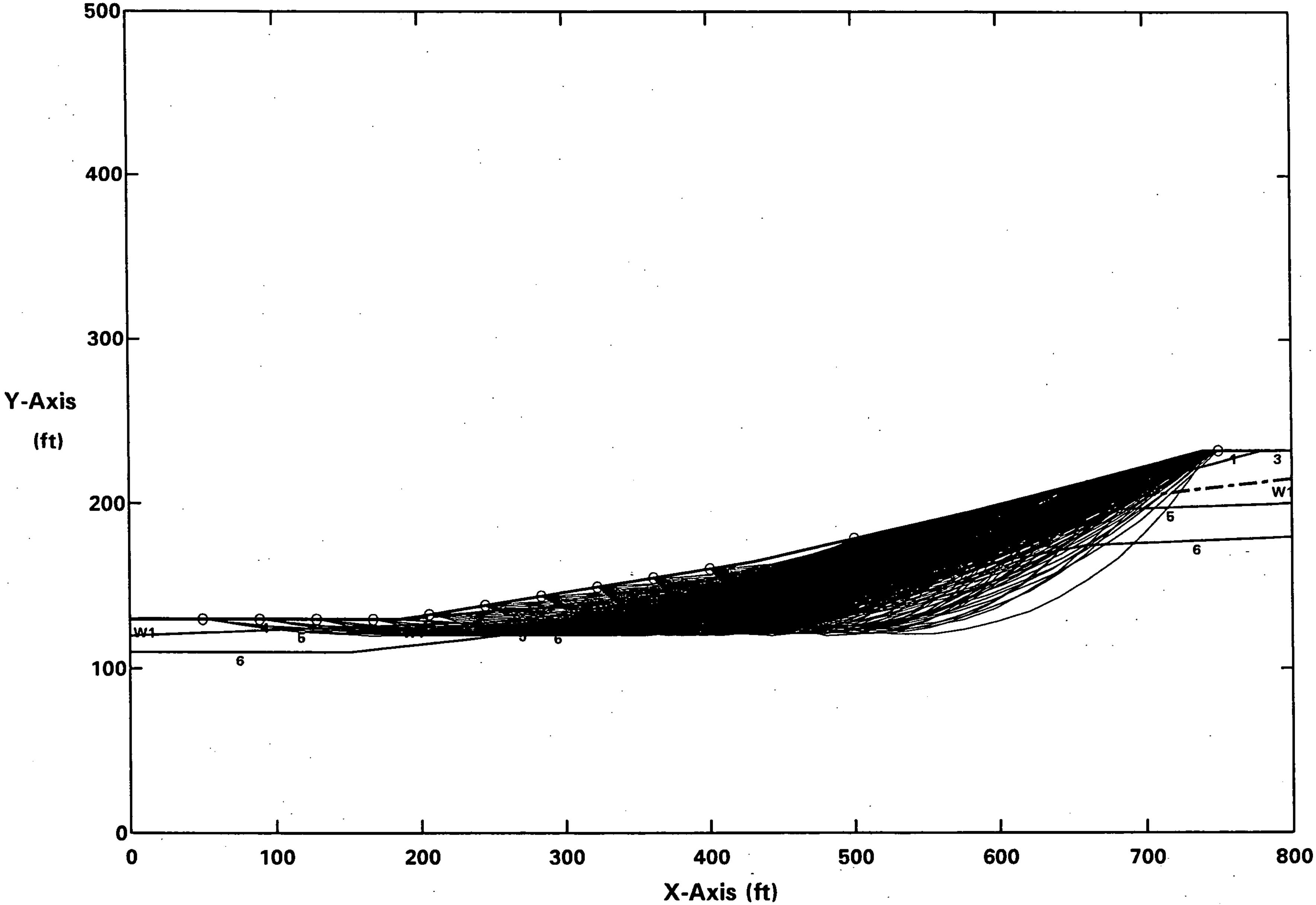
ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:DEHC06.PLT By: STAN KLINE 10-26-04 12:25am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

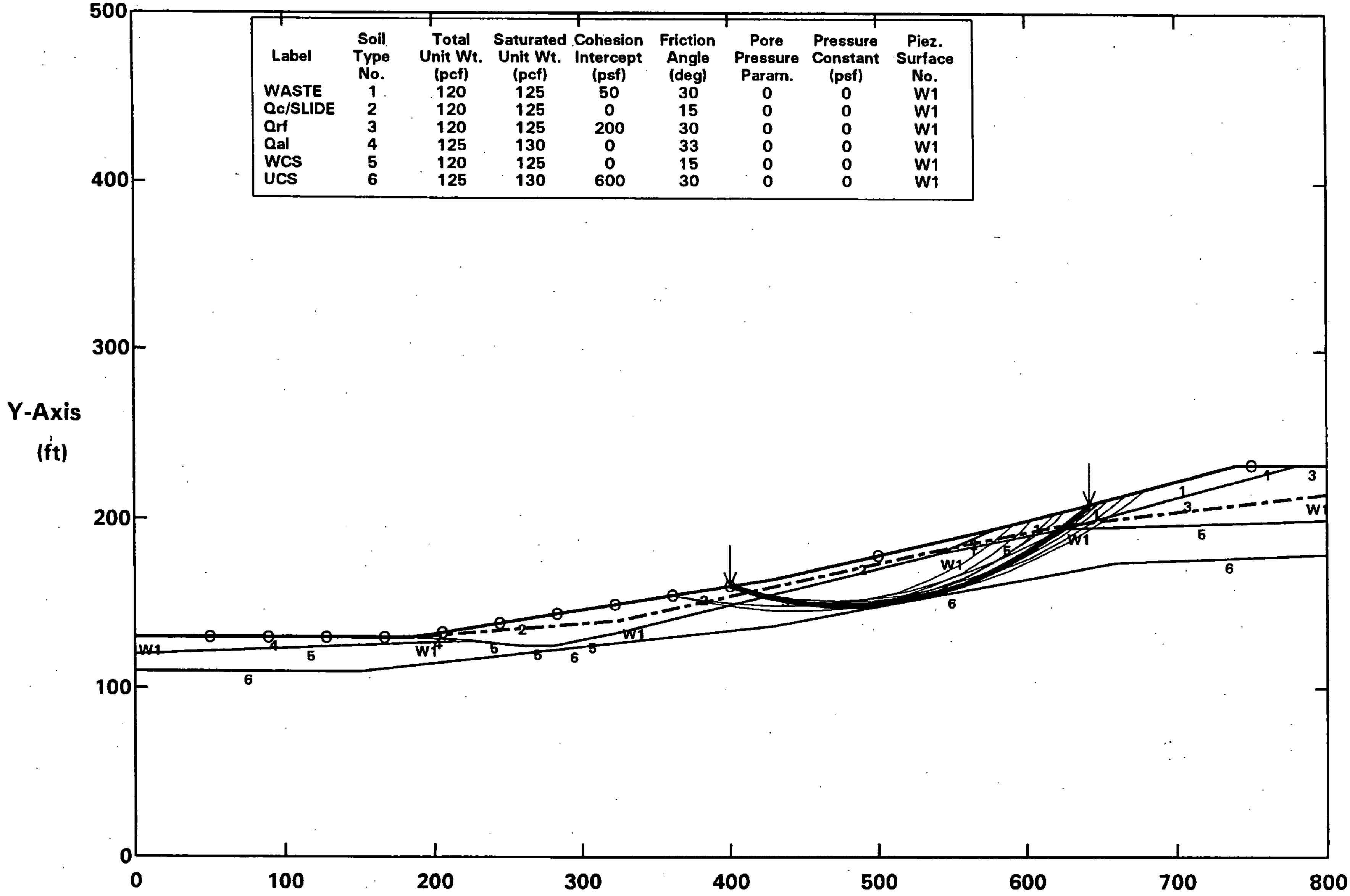
PCSTABL5M/SI FSmin = 0.71 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E SECTION D - WCS = 15deg - W/HIGHGW - CIRCULAR - 0.0g(STATIC)
All surfaces evaluated. C:DEHC00.PLT By: STAN KLINE 10-26-04 12:24am



Factors Of Safety Calculated By The Modified Bishop Method

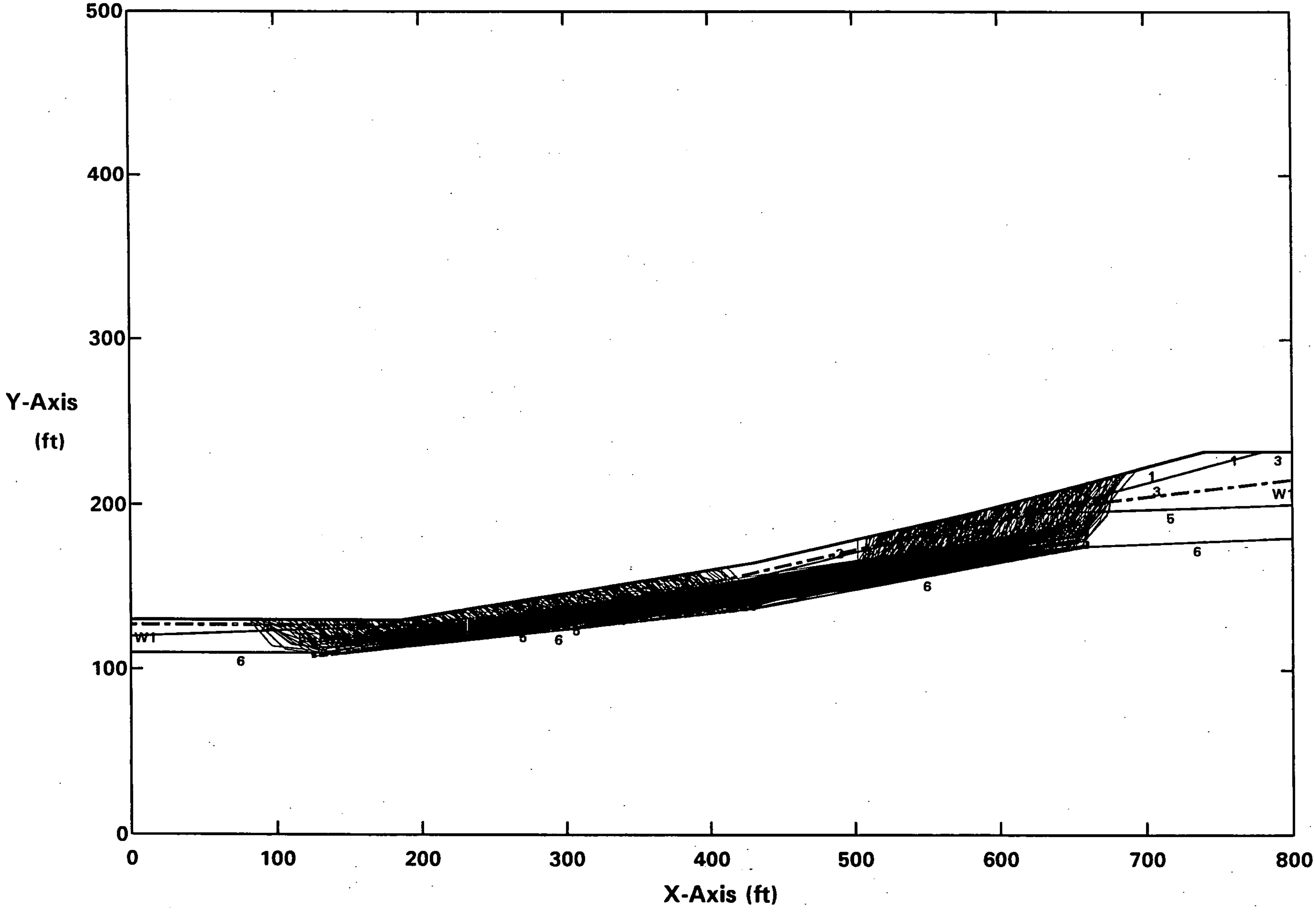
ROCKY FLATS OLF - M&E SECTION D - WCS = 15deg - W/HIGHGW - CIRCULAR - 0.0g(STATIC)
Ten Most Critical. C:DEHC00.PLT By: STAN KLINE 10-26-04 12:24am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 0.94 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

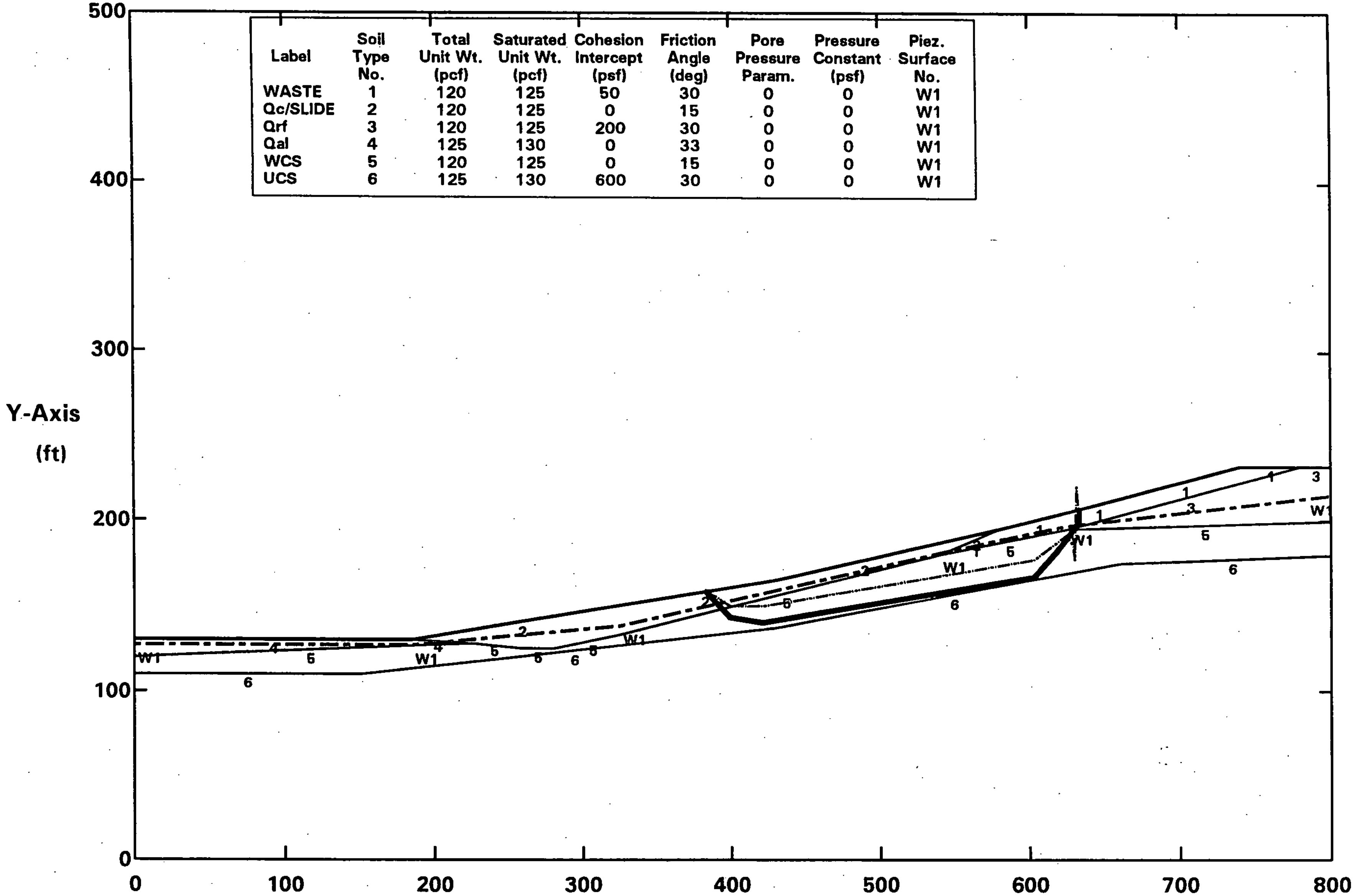
ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:DEAS06.PLT By: STAN KLINE 10-24-04 7:52pm



Factors Of Safety Calculated By The Modified Janbu Method

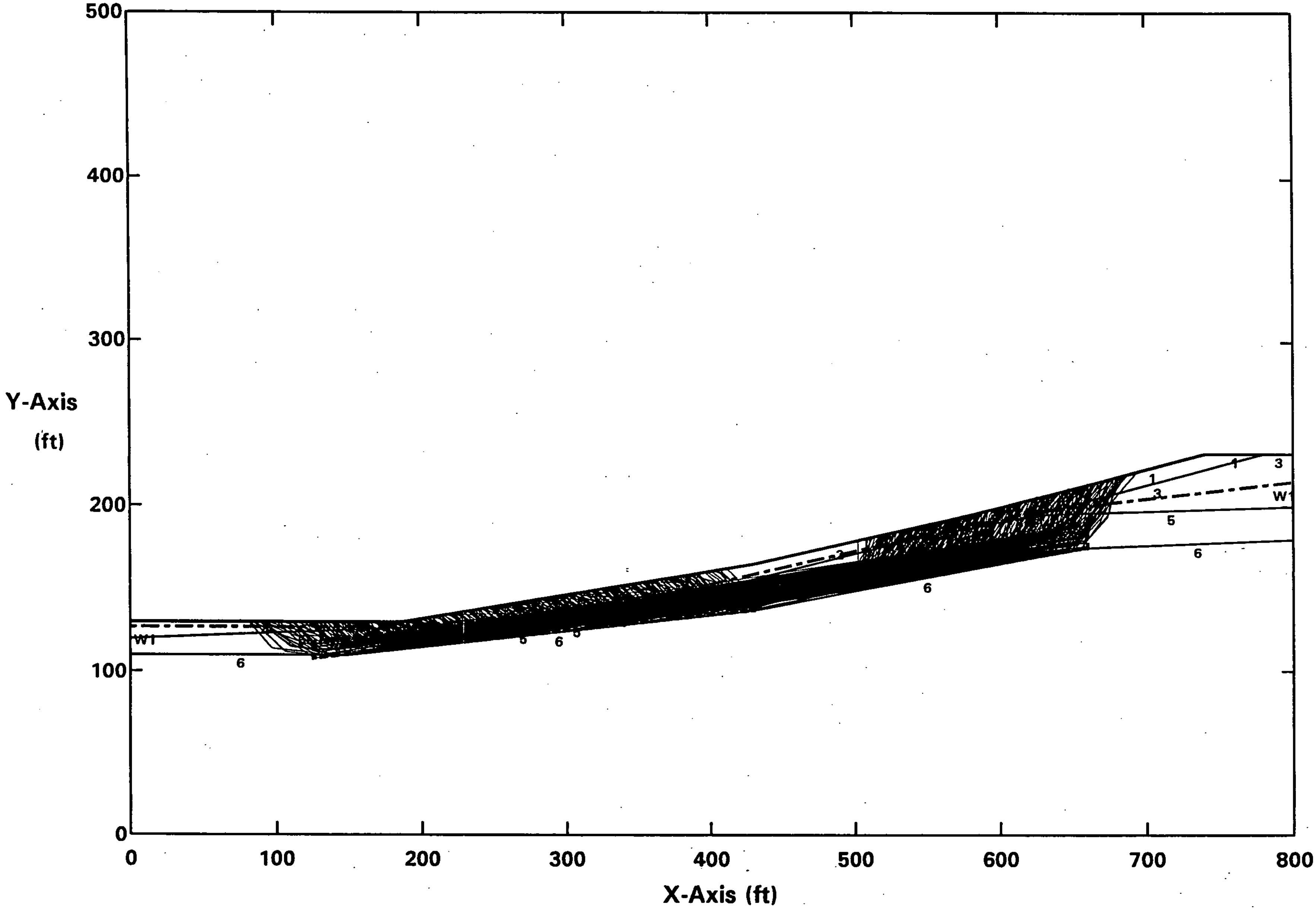
ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-DEAS06.OUT. C:DEAS06SP.PLT By: STAN KLINE 10-24-04 7:53pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS = 0.80 Theta = 8.42 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

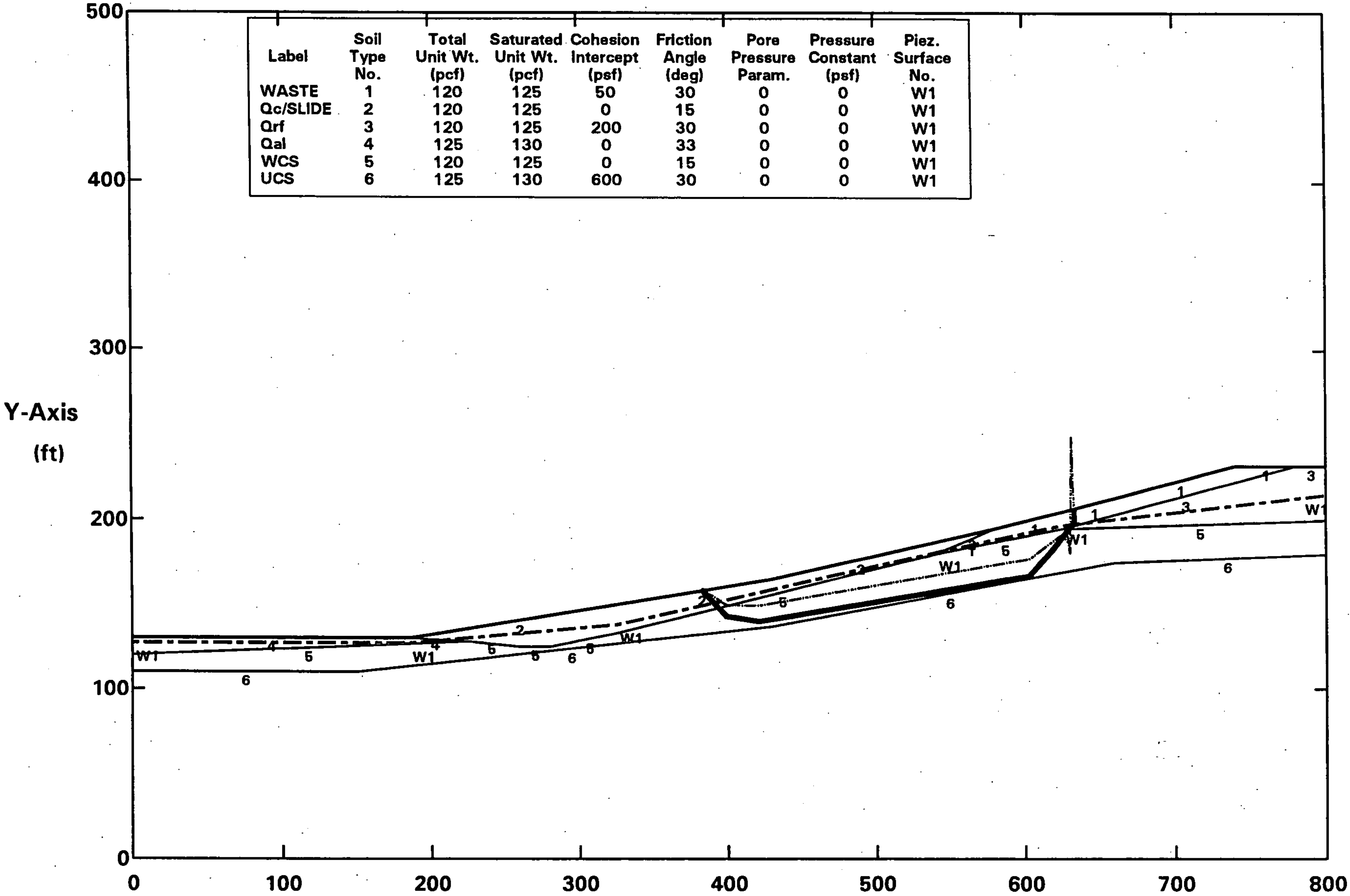
ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.01g
All surfaces evaluated. C:DEAS01.PLT By: STAN KLINE 10-24-04 7:42pm



Factors Of Safety Calculated By The Modified Janbu Method

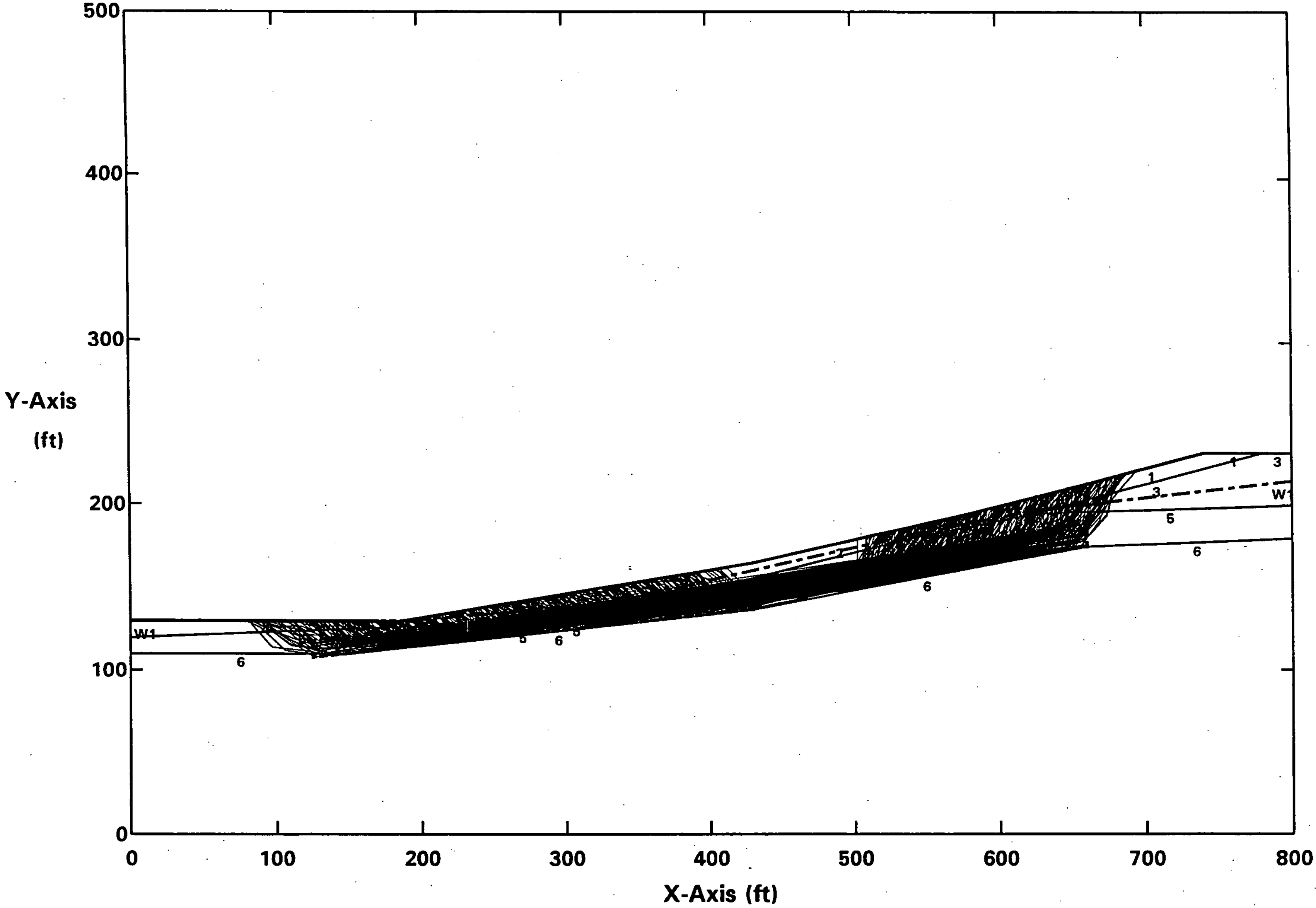
ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.01g
Surface #1-DEAS01.OUT. C:DEAS01SP.PLT By: STAN KLINE 10-24-04 7:44pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



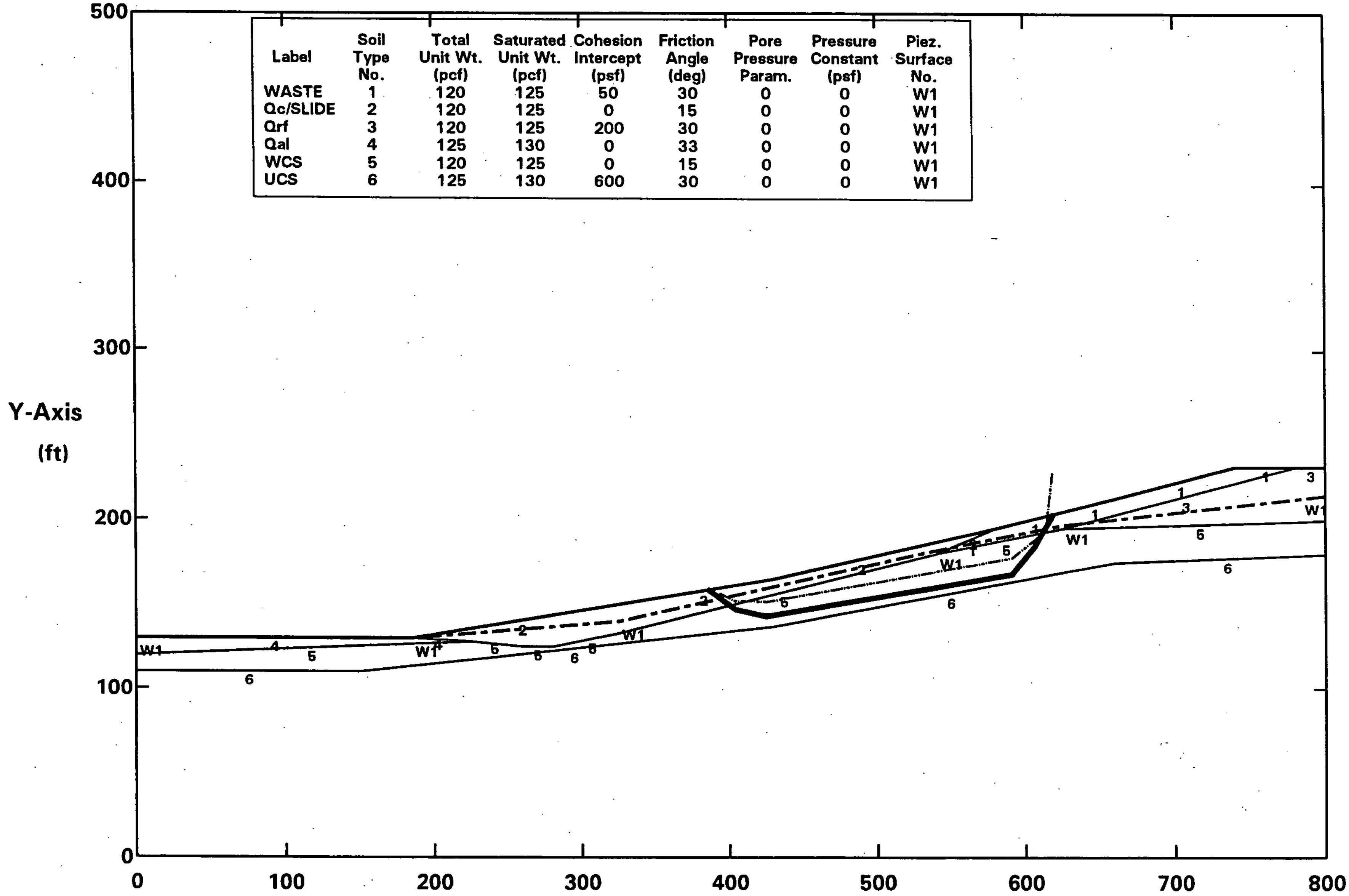
PCSTABL5M/SI FS = 1.02 Theta = 8.76 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:DEHS06.PLT By: STAN KLINE 10-24-04 8:27pm



Factors Of Safety Calculated By The Modified Janbu Method

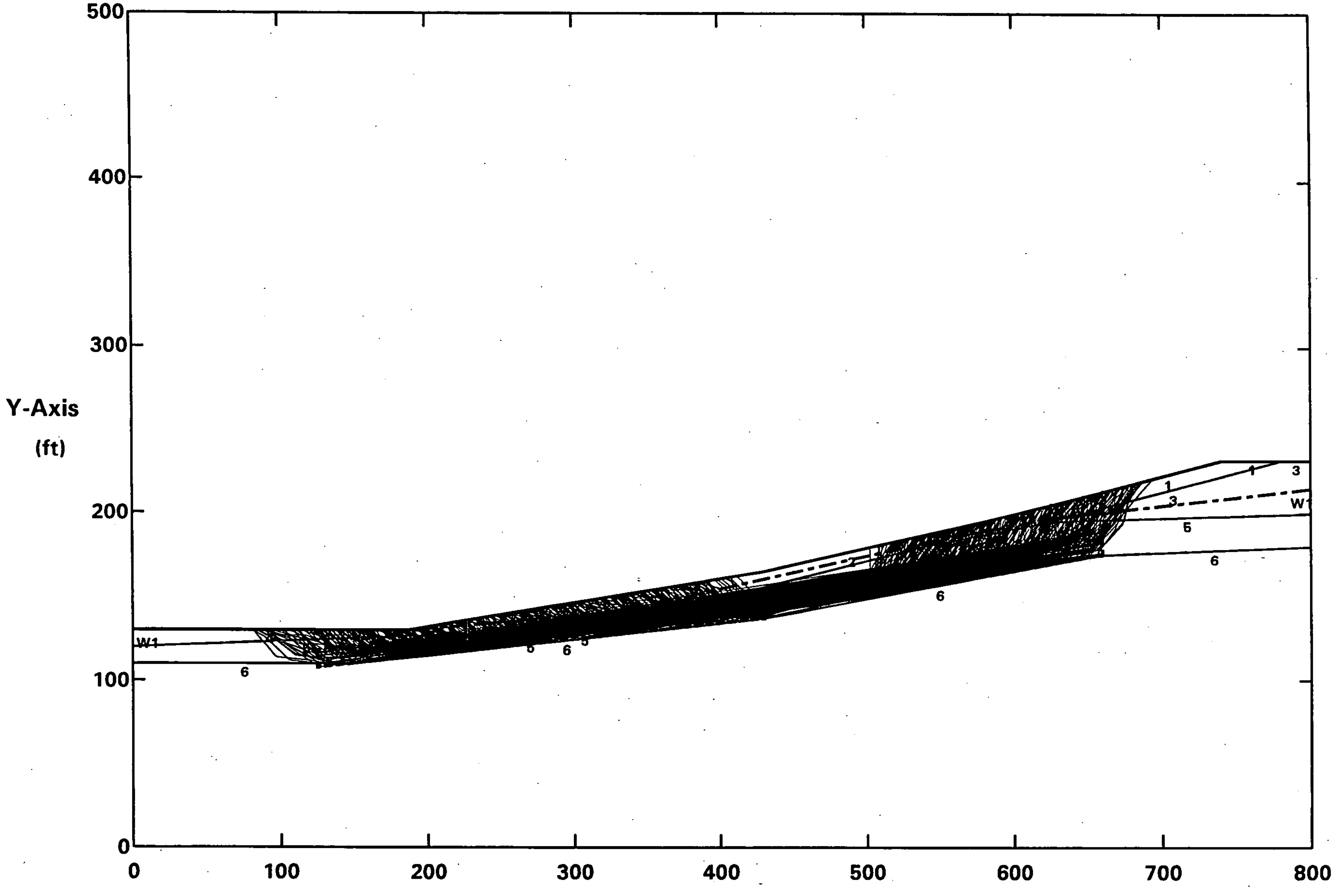
ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-DEHS06.OUT. C:DEHS06SP.PLT By: STAN KLINE 10-24-04 8:30pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS = 0.76 Theta = 8.79 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

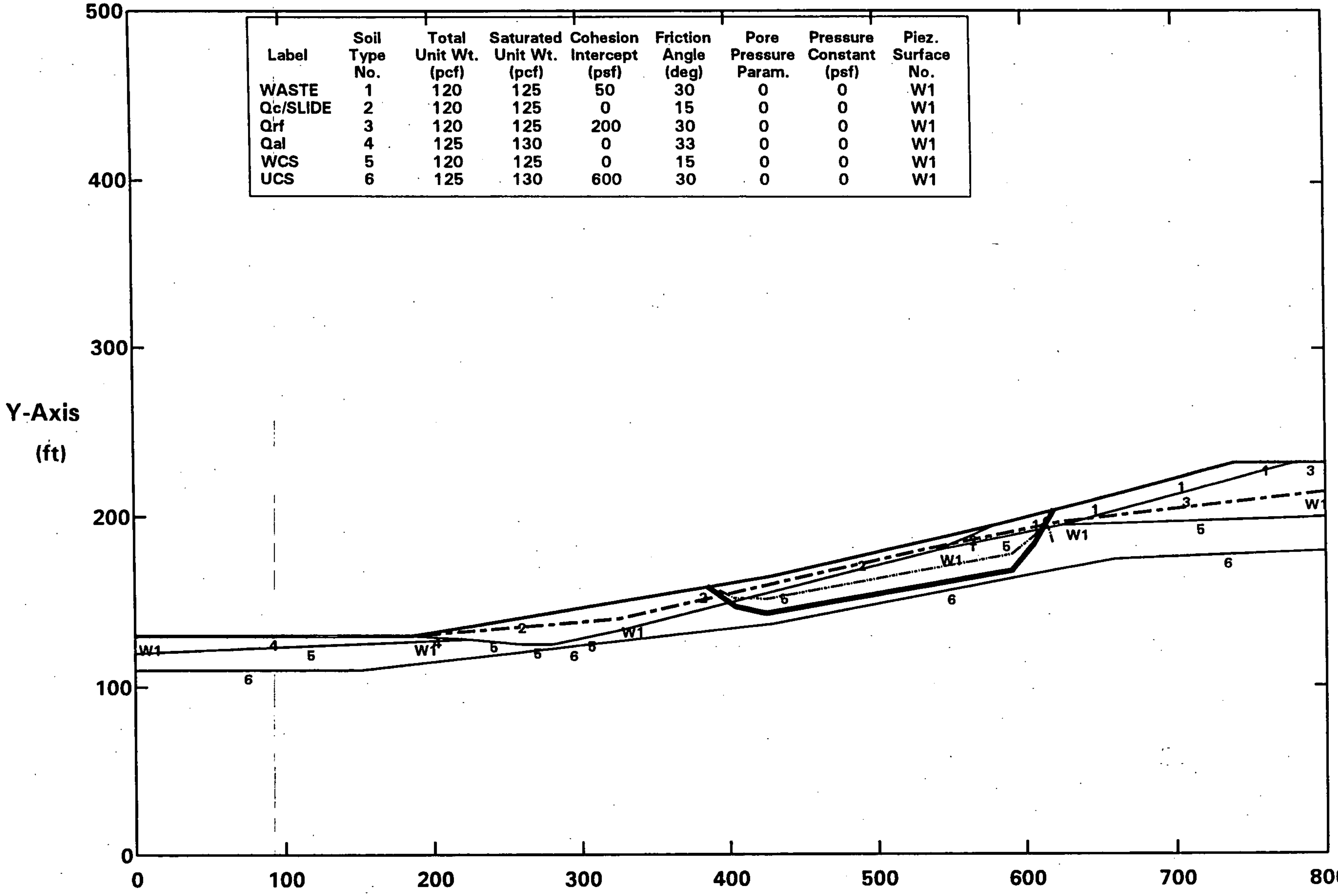
ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.005g
All surfaces evaluated. C:DEHS01.PLT By: STAN KLINE 10-24-04 8:24pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E SECTION D - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.005g
Surface #1-DEHS01.OUT. C:DEHS01SP.PLT By: STAN KLINE 10-24-04 8:26pm

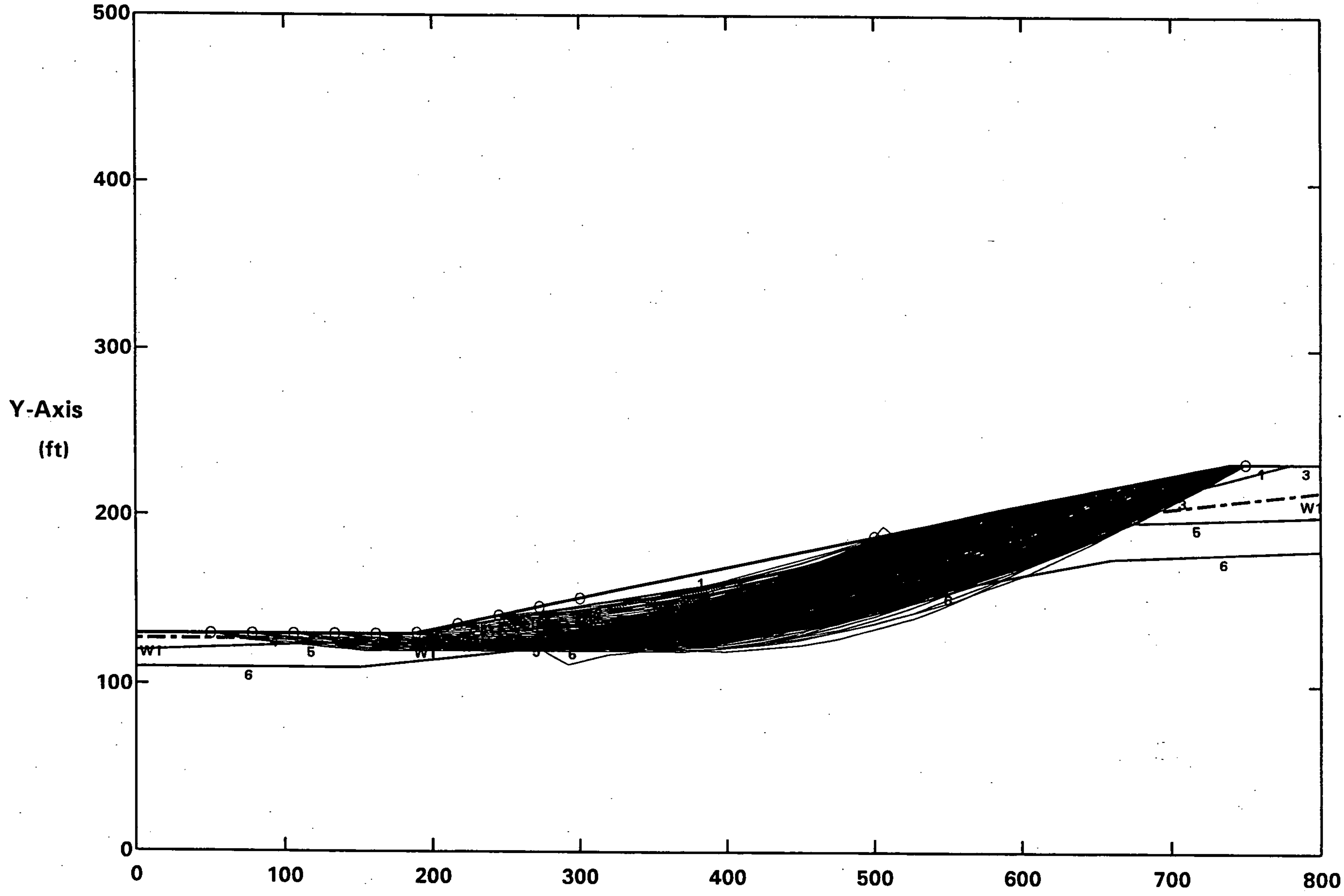
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WASTE	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FS = 1.00 Theta = 9.18 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

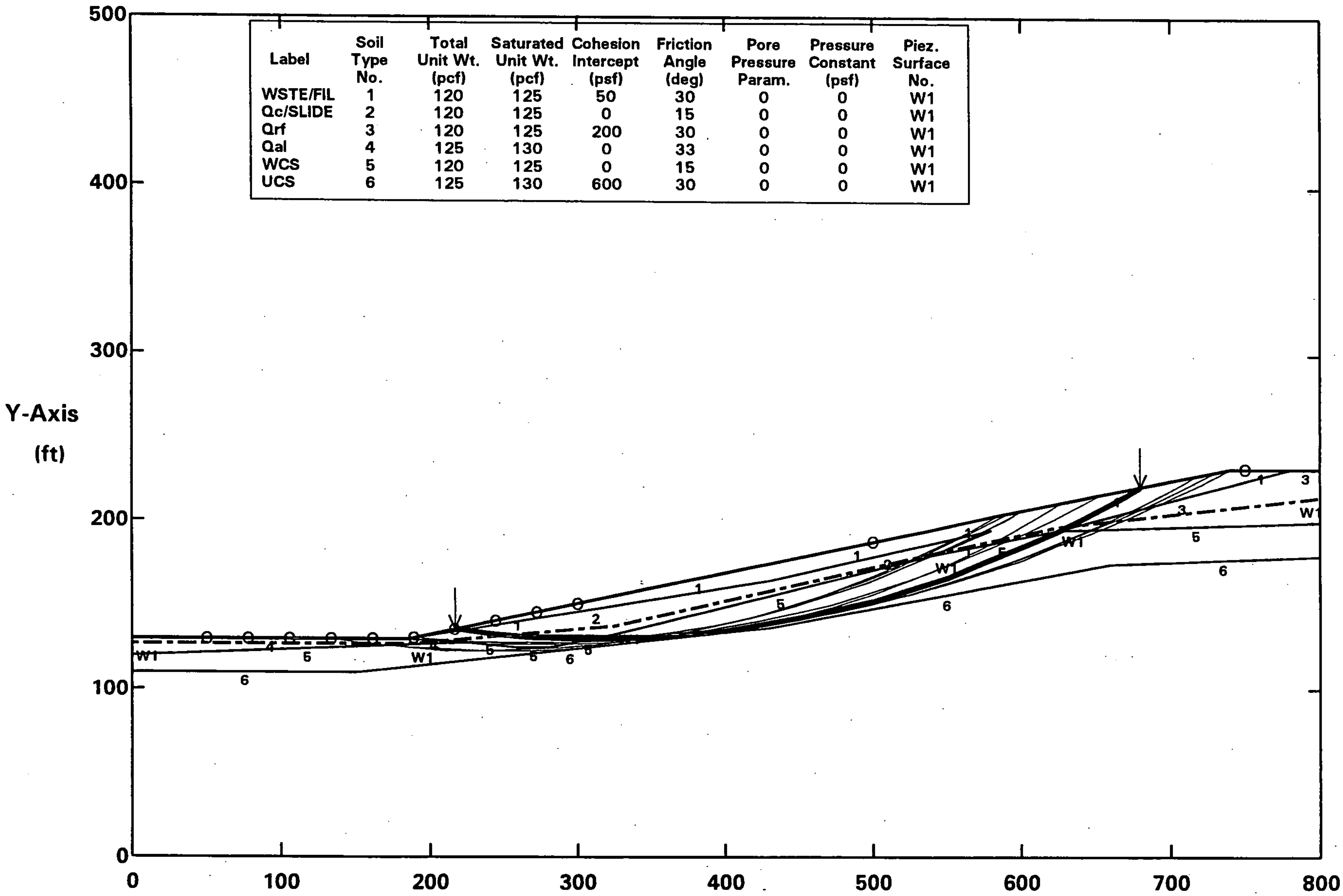
18% REGRADE CONDITION

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:DGAC06.PLT By: STAN KLINE 10-26-04 12:22am



Factors Of Safety Calculated By The Modified Bishop Method

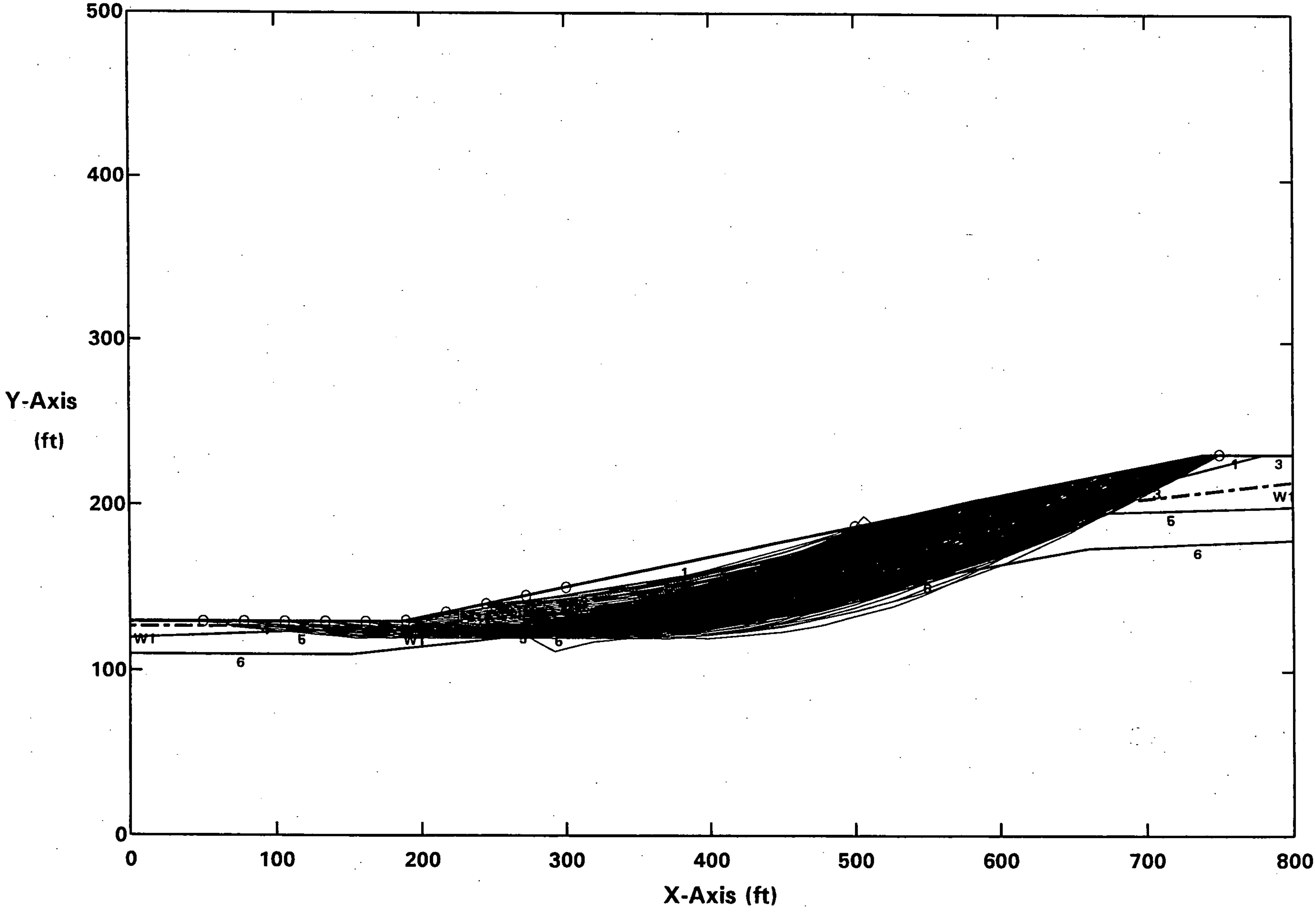
ROCKY FLATS OLF - M&E D 18% GRD - WCS=15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:DGAC06.PLT By: STAN KLINE 10-26-04 12:22am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin=0.92 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

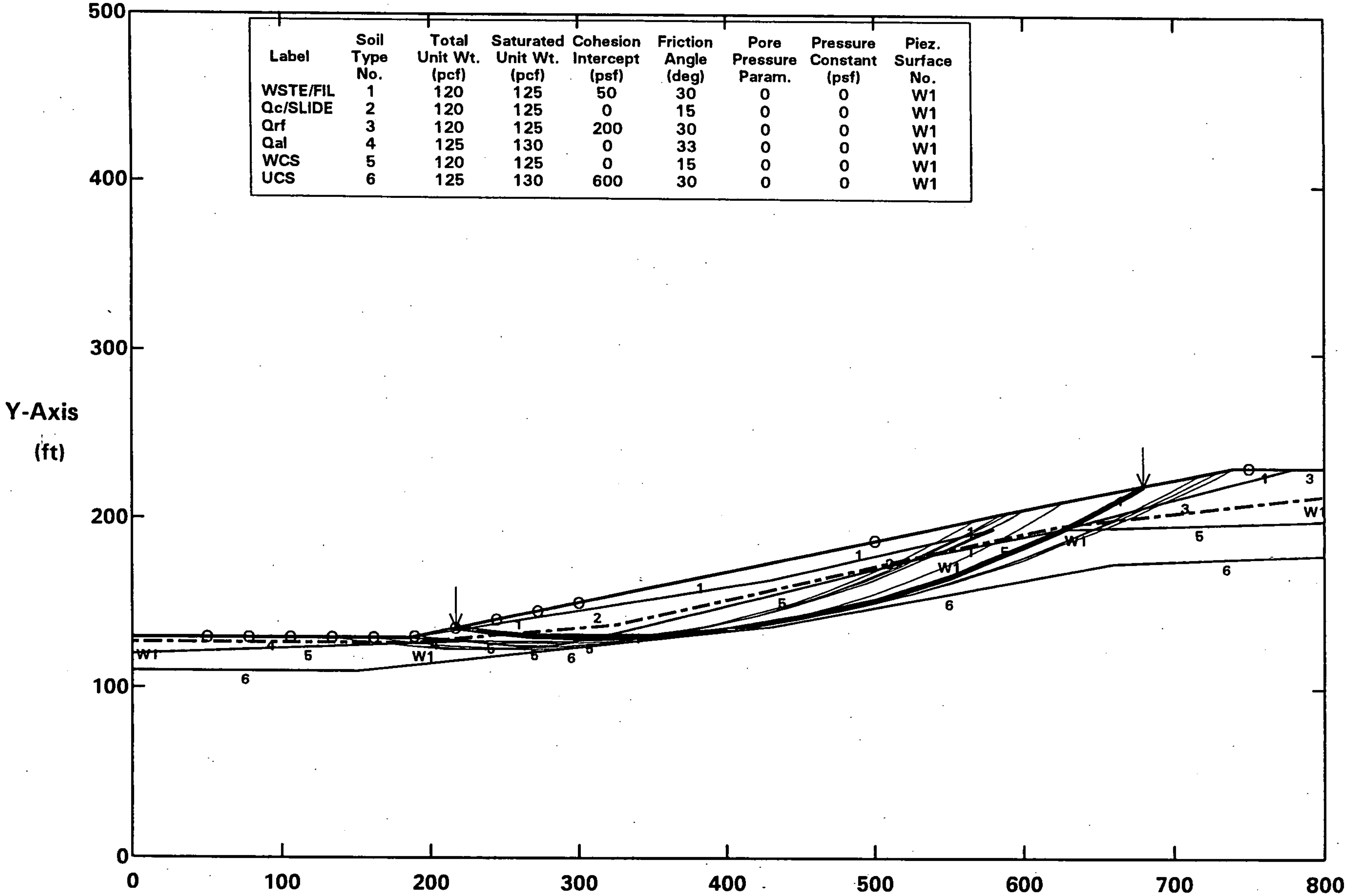
ROCKY FLATS OLF - M&E D 18% GRD - WCS=15 deg - W/AVEGW - CIRCULAR - 0.04g
All surfaces evaluated. C:DGAC04.PLT By: STAN KLINE 10-26-04 12:21am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS=15 deg - W/AVEGW - CIRCULAR - 0.04g
Ten Most Critical. C:DGAC04.PLT By: STAN KLINE 10-26-04 12:21am

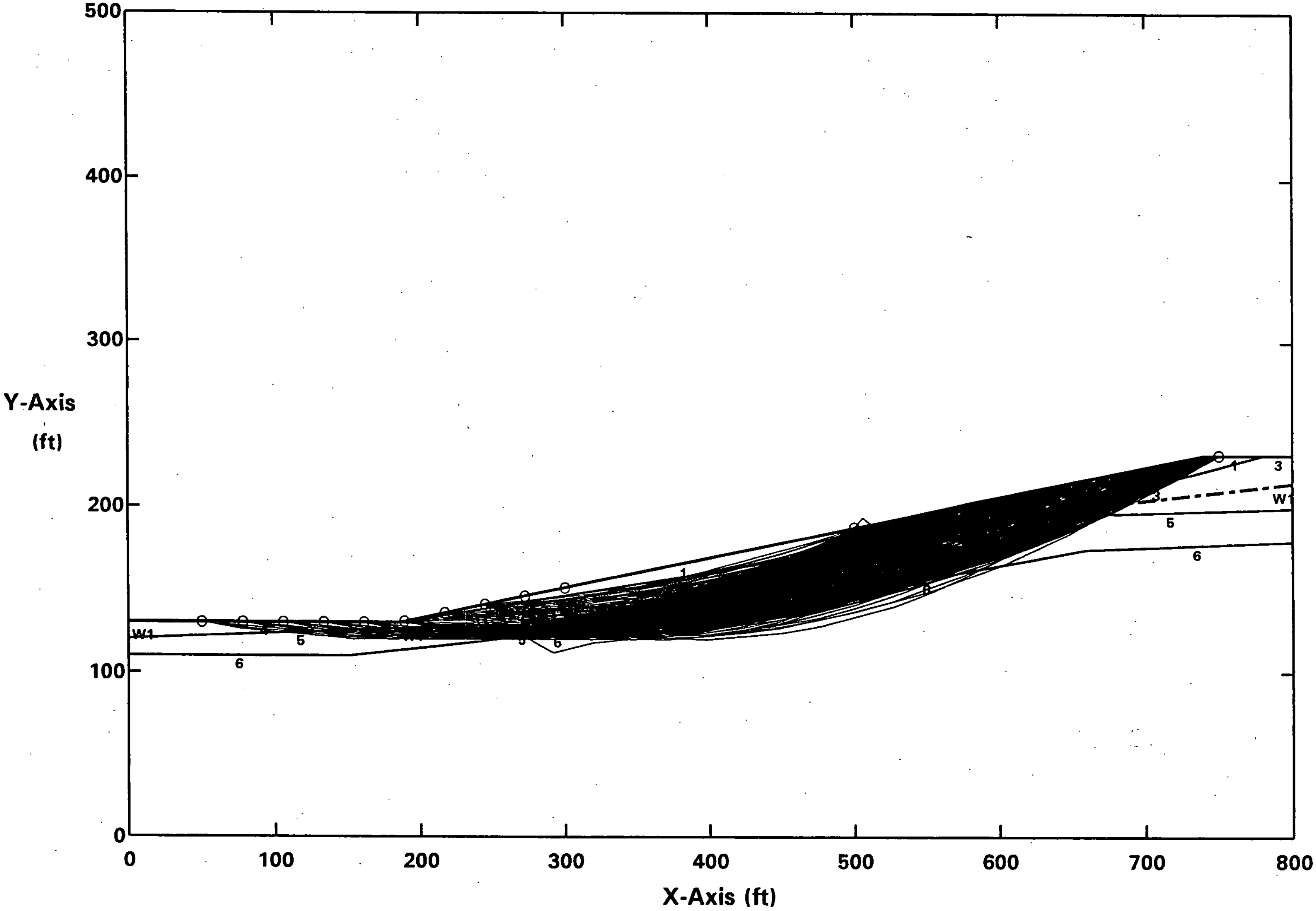
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



PCSTABL5M/SI FSmin=1.01 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

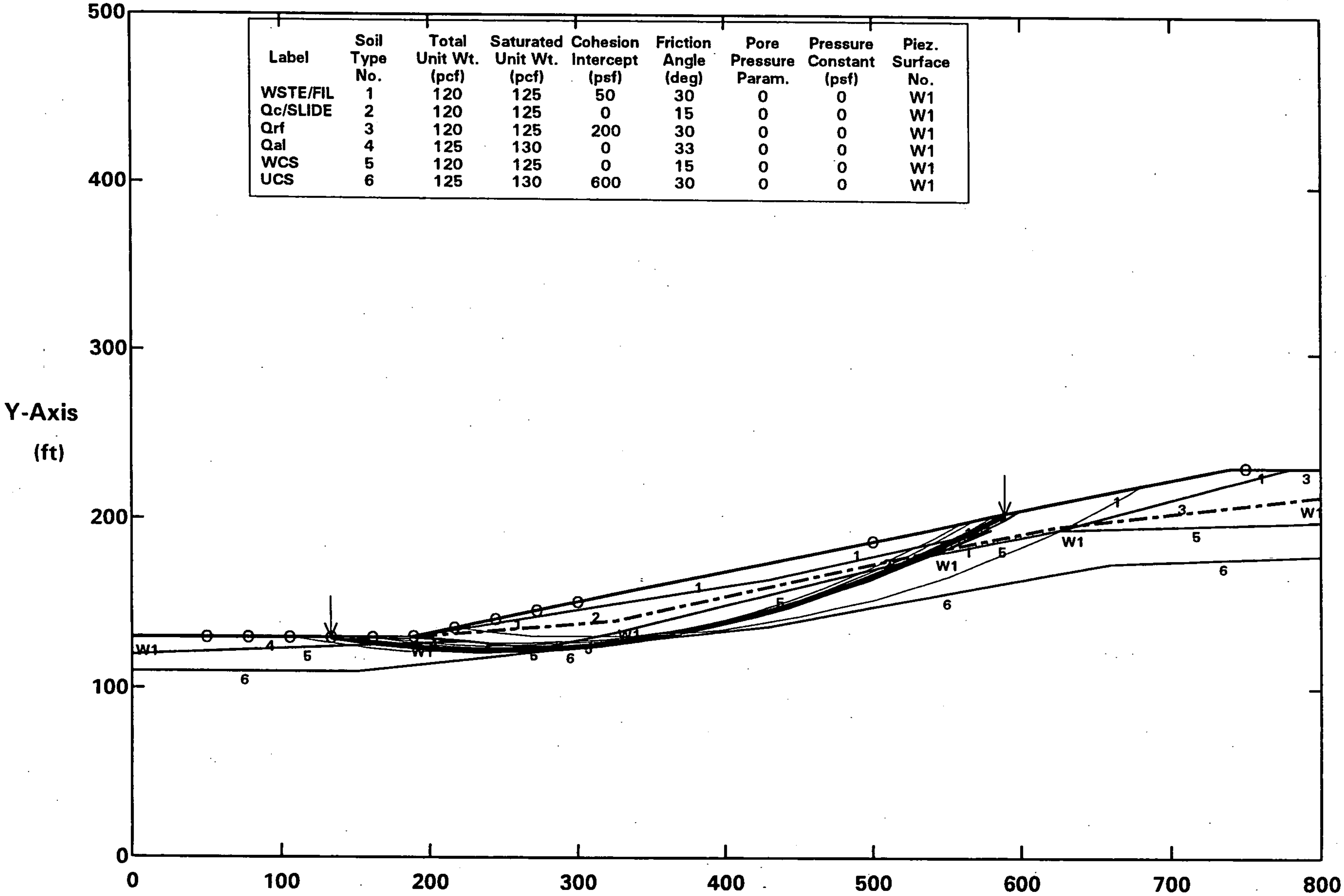
ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g

All surfaces evaluated. C:DGHC06.PLT By: STAN KLINE 10-26-04 12:26am



Factors Of Safety Calculated By The Modified Bishop Method

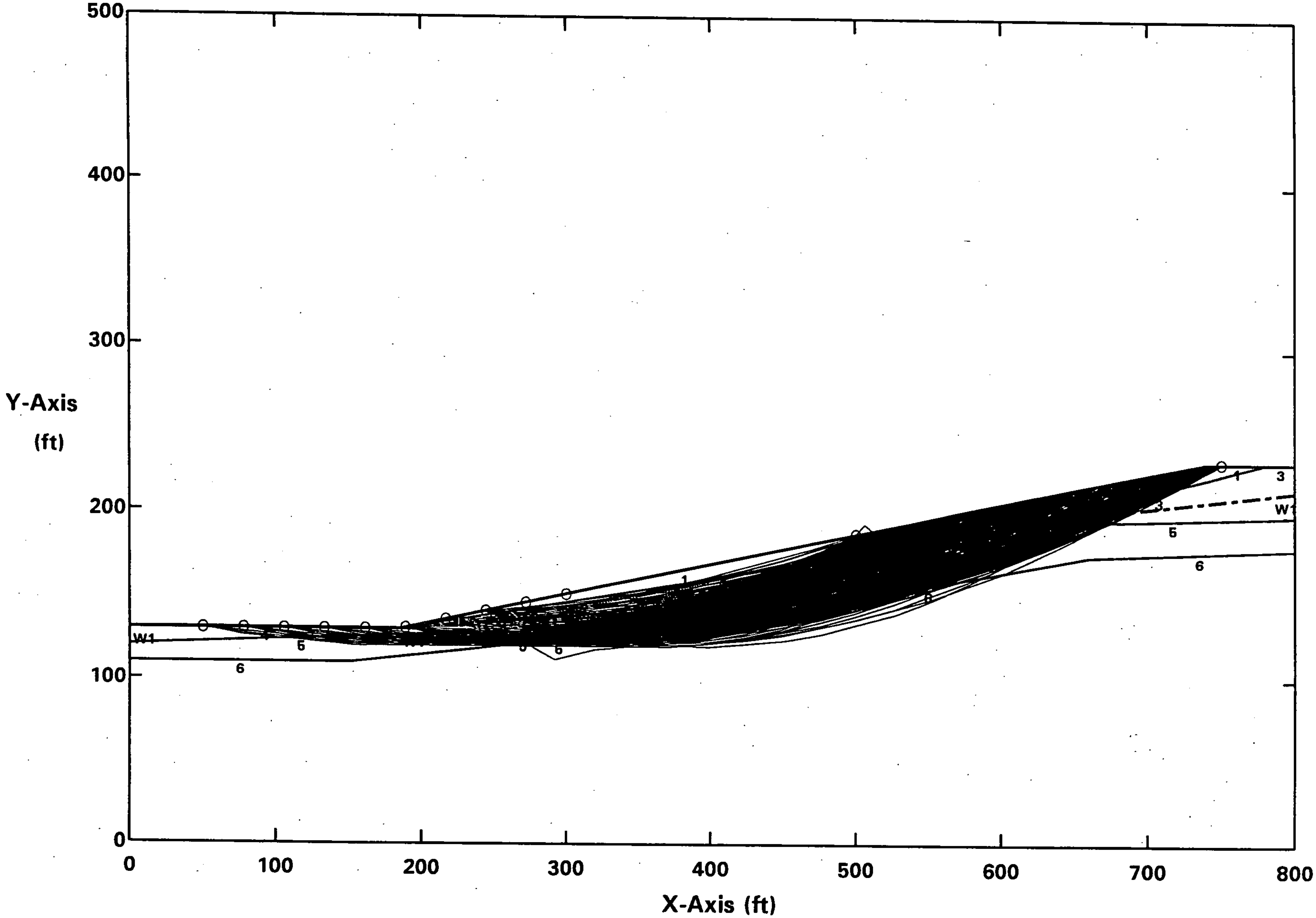
ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:DGHC06.PLT By: STAN KLINE 10-26-04 12:26am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 0.88 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

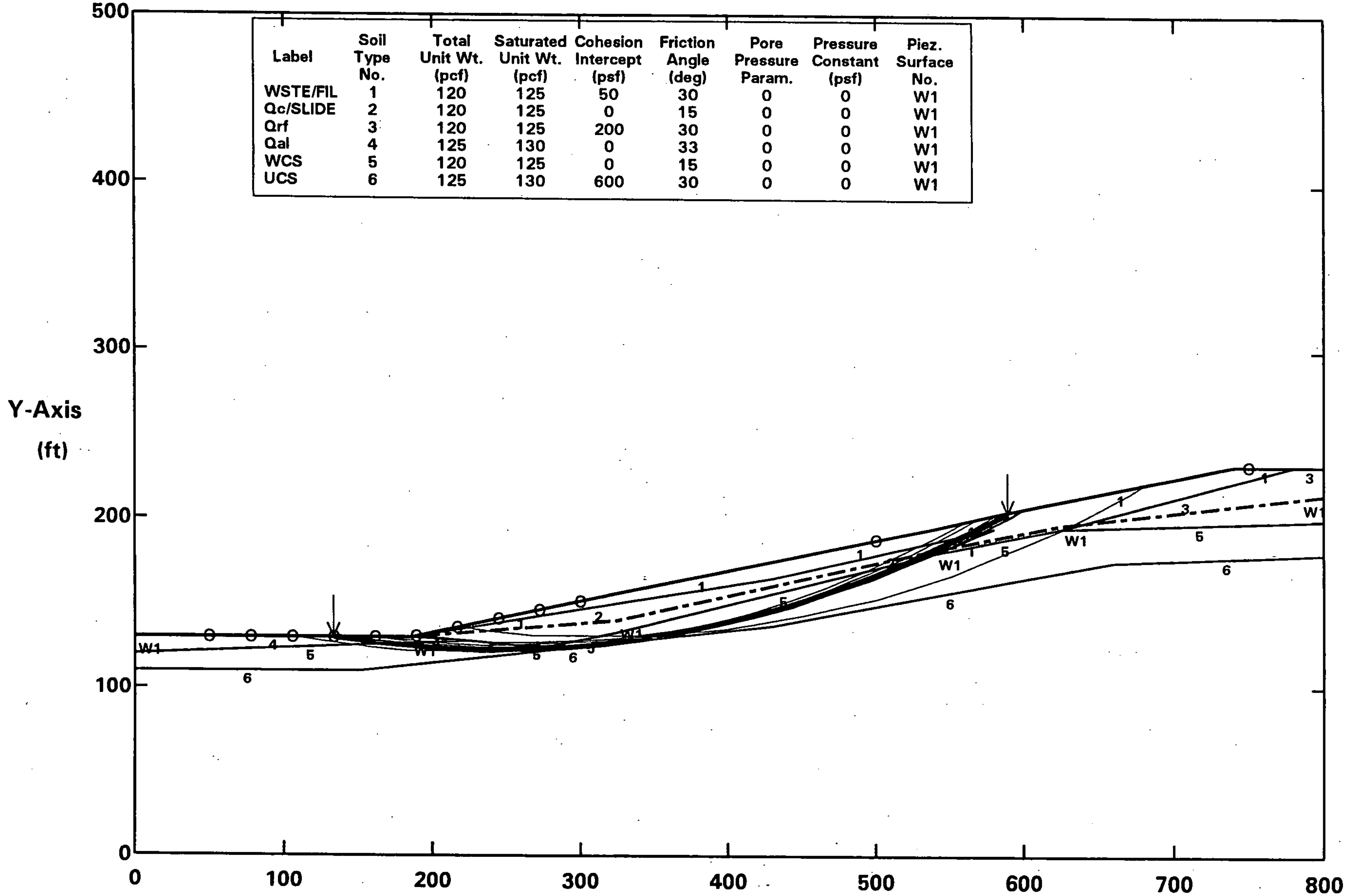
ROCKY FLATS OLF - M&E D 18% GRD - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.03g
All surfaces evaluated. C:DGHC03.PLT By: STAN KLINE 10-26-04 12:26am



Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/HIGHGW - CIRCULAR - 0.03g

Ten Most Critical. C:DGHC03.PLT By: STAN KLINE 10-26-04 12:26am

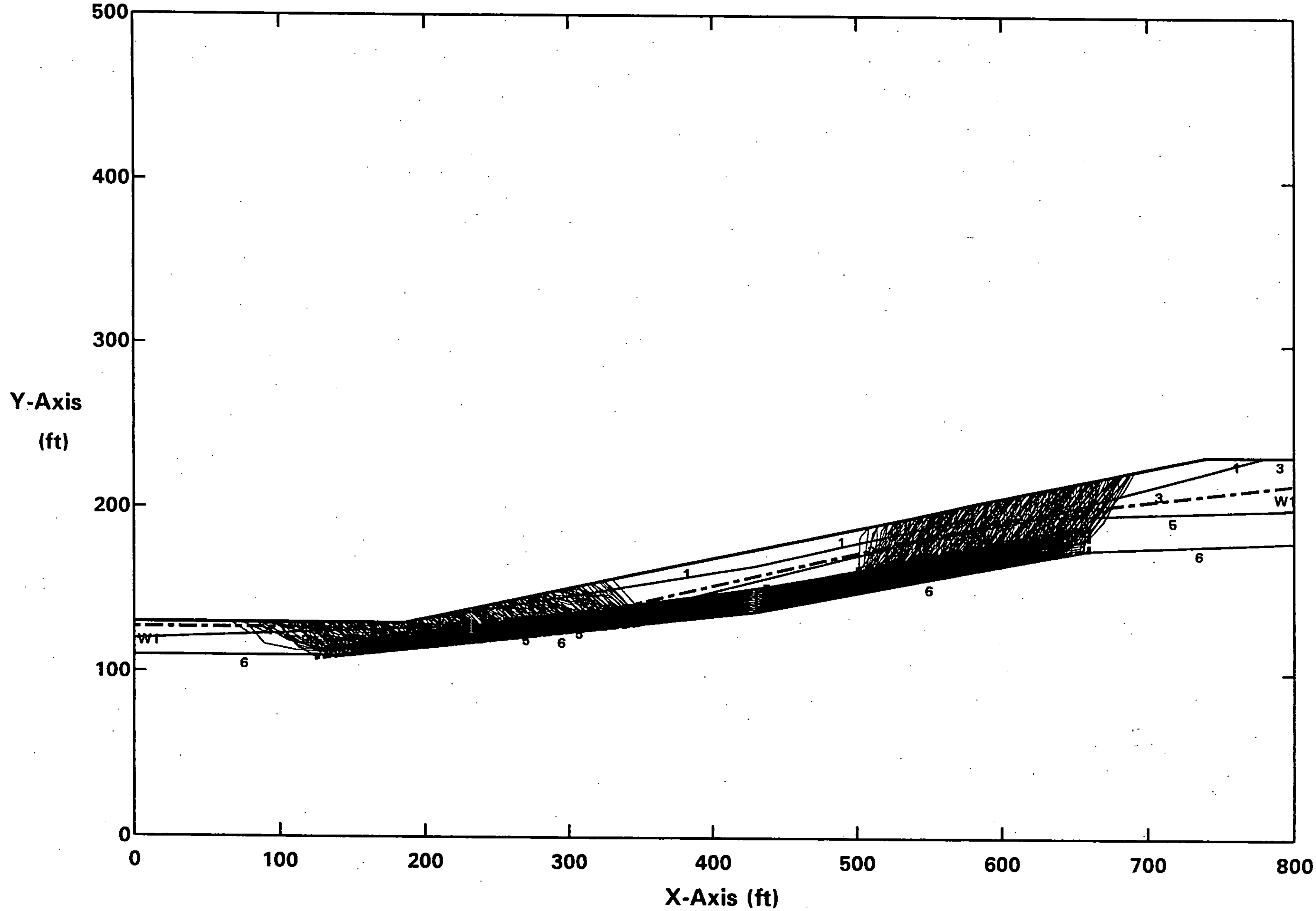


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FSmin = 1.02 X-Axis (ft)

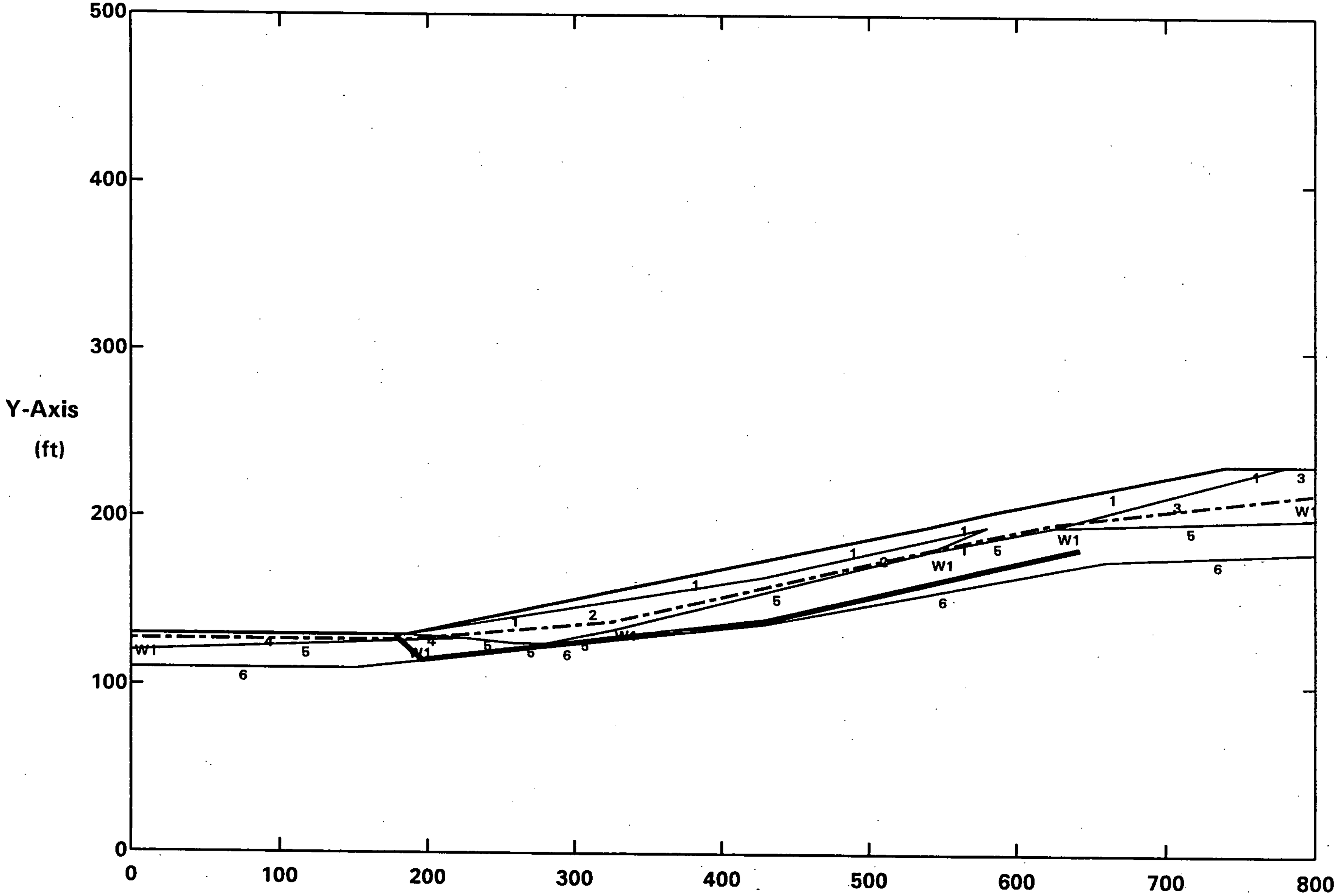
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:DGAS06.PLT By: STAN KLINE 10-24-04 7:59pm



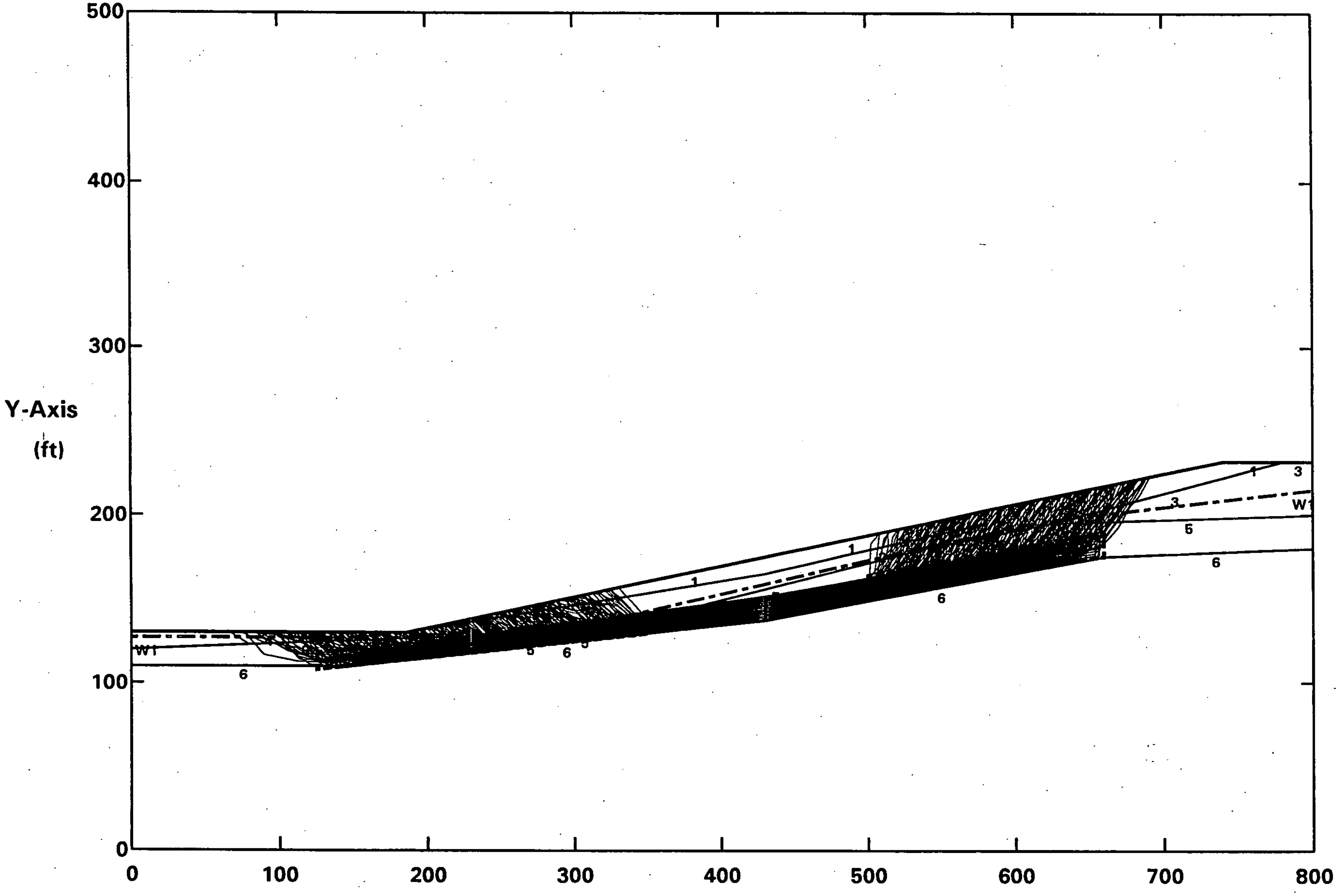
Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-DGAS06.OUT. C:DGAS06SP.PLT By: STAN KLINE 10-24-04 11:16pm



PCSTABL5M/SI FS = 0.88 Theta = 9 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

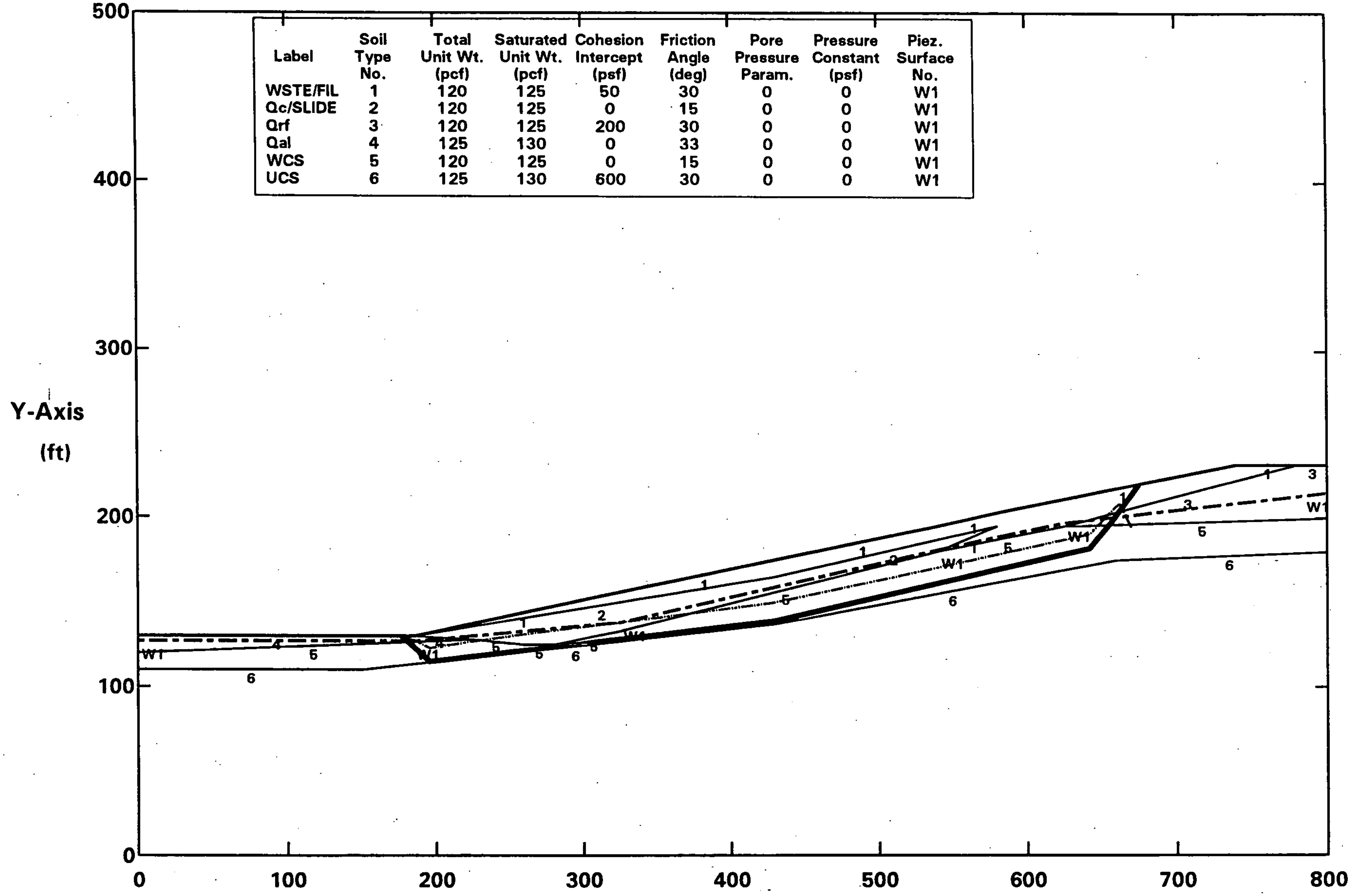
ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.03g
All surfaces evaluated. C:DGAS03.PLT By: STAN KLINE 10-24-04 7:56pm



Factors Of Safety Calculated By The Modified Janbu Method

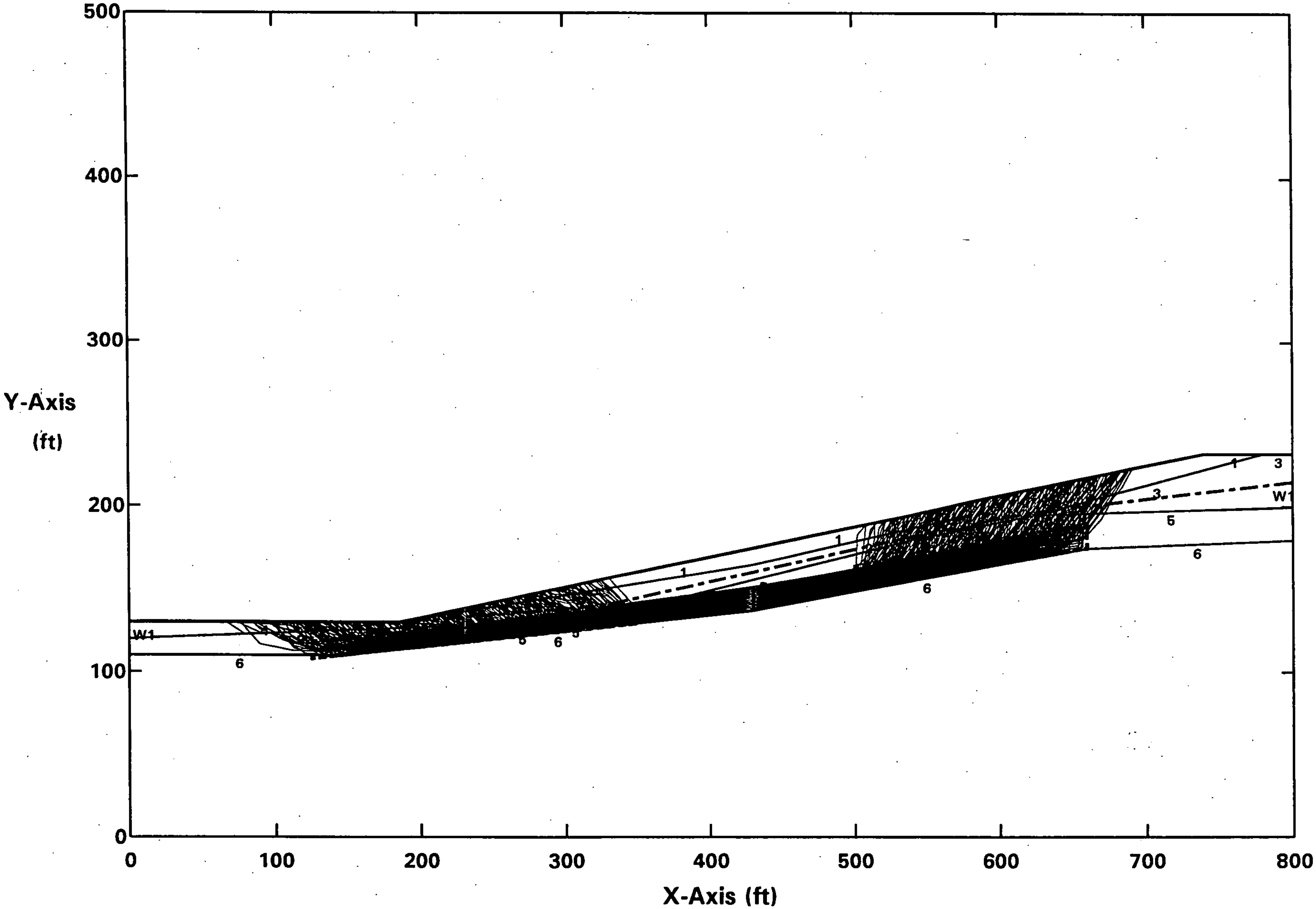
ROCKY FLATS OLF - M&E D 18% GRD - WCS=15 deg - W/AVEGW - SLIDING BLOCK - 0.03g
Surface #1-DGAS03.OUT. C:DGAS03SP.PLT By: STAN KLINE 10-24-04 7:58pm

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1



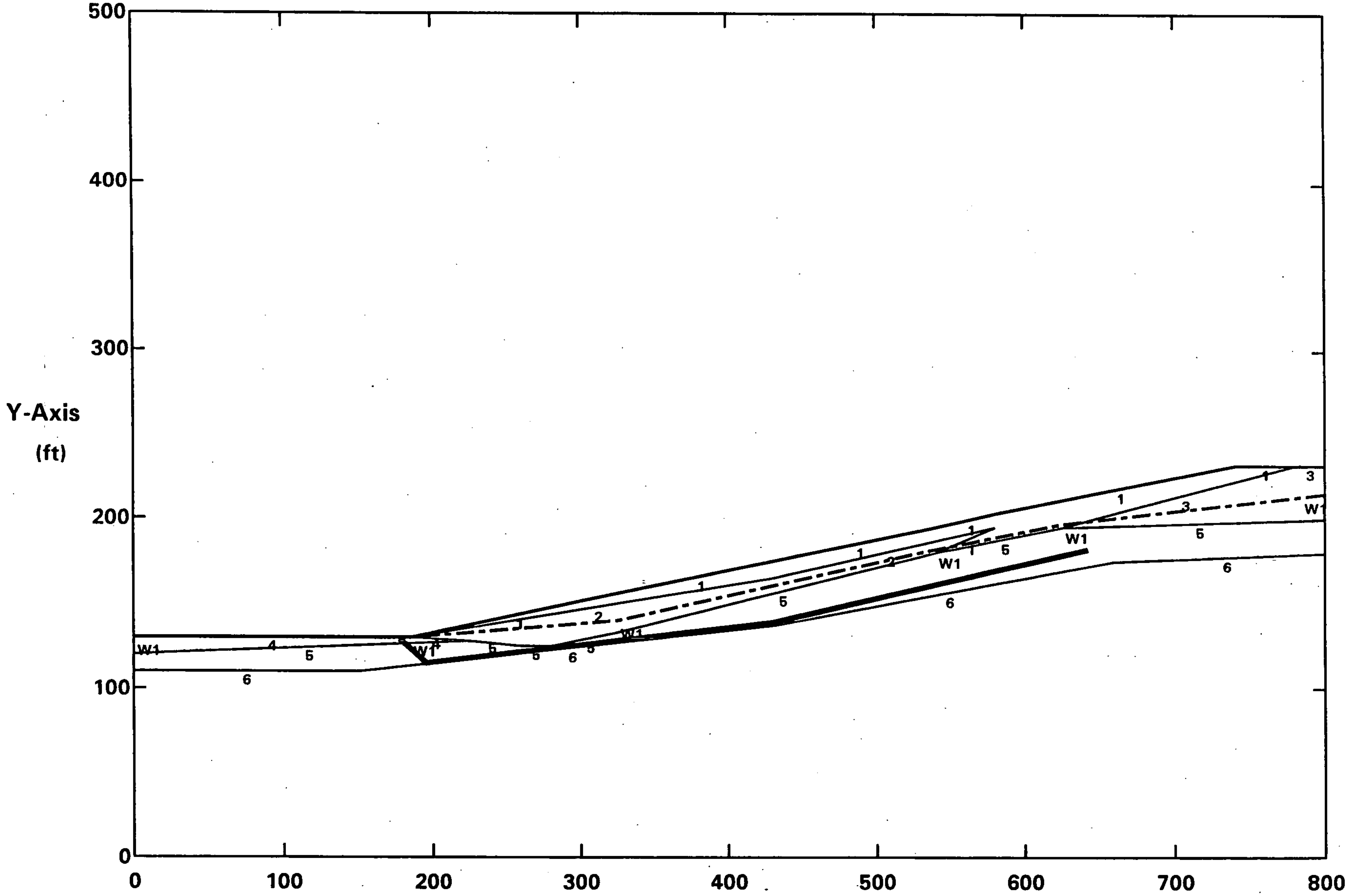
PCSTABL5M/SI FS=1.02 Theta=8.87 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:DGHS06.PLT By: STAN KLINE 10-24-04 8:38pm



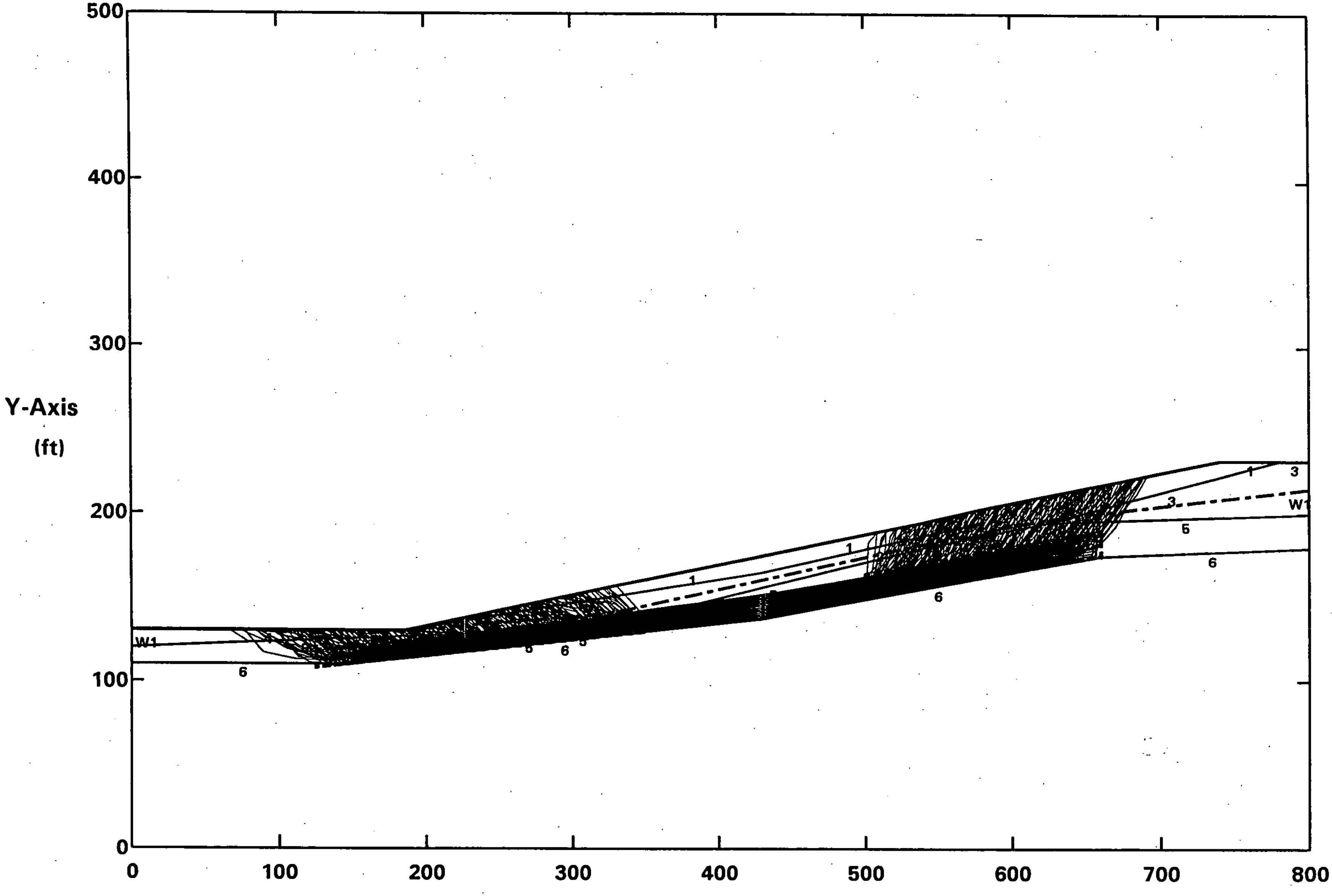
Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.06g
Surface #1-DGHS06.OUT. C:DGHS06SP.PLT By: STAN KLINE 10-24-04 8:55pm



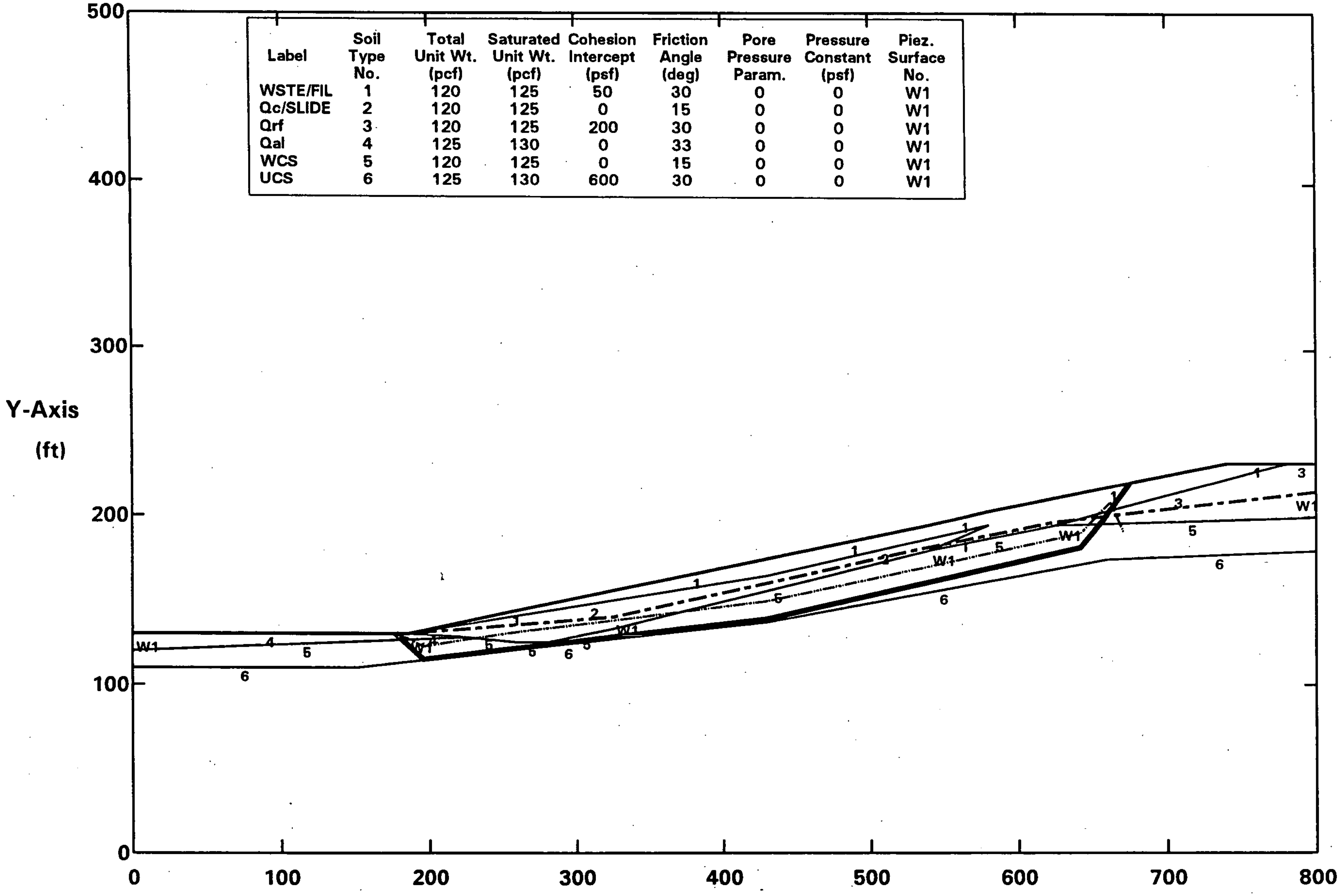
PCSTABL5M/SI FS = 0.85 Theta = 8.95 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.02g
All surfaces evaluated. C:DGHS02.PLT By: STAN KLINE 10-24-04 8:35pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E D 18% GRD - WCS = 15 deg - W/HIGHGW - SLIDING BLOCK - 0.02g
Surface #1-DGHS02.OUT. C:DGHS02SP.PLT By: STAN KLINE 10-24-04 8:37pm

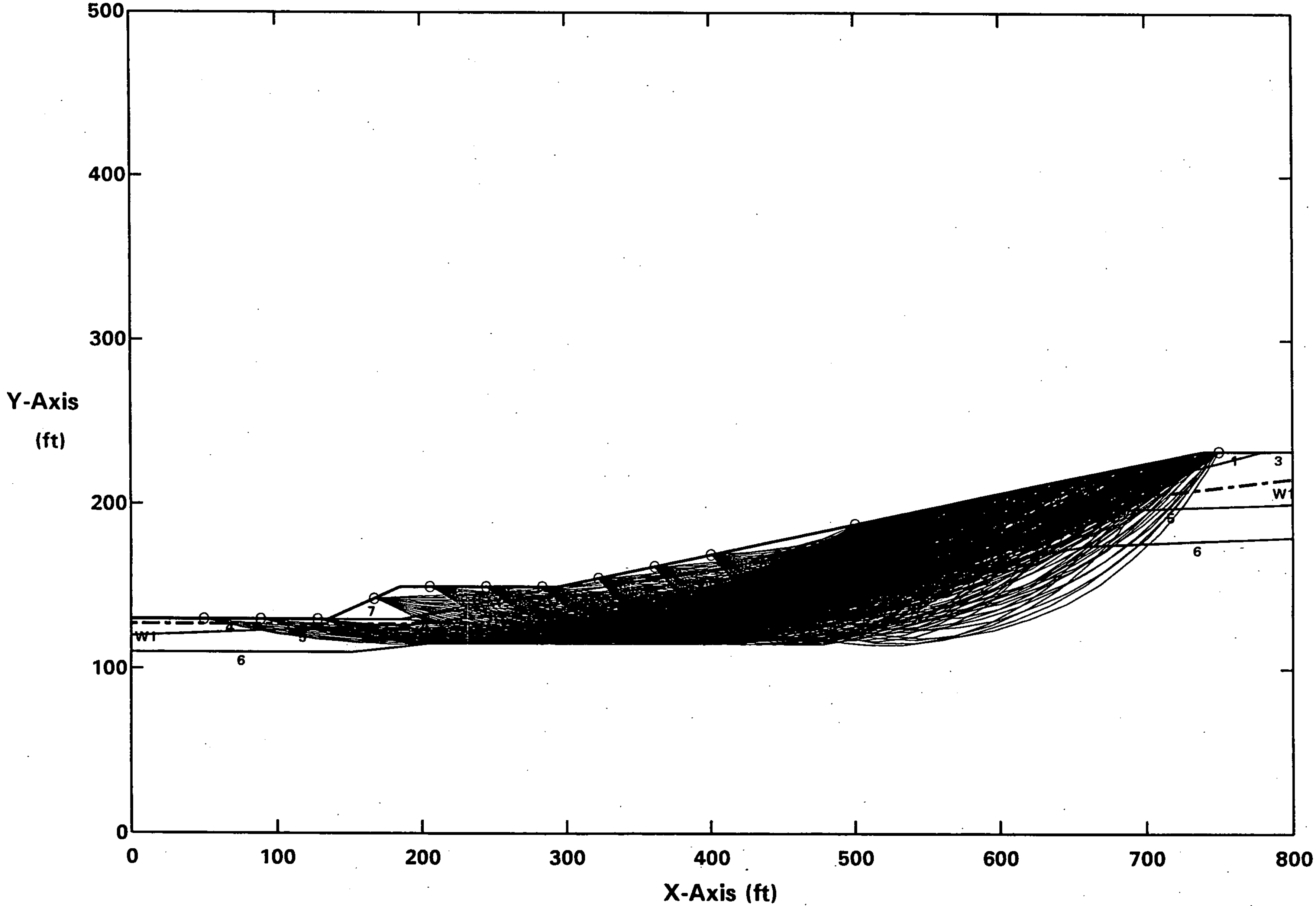


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1

PCSTABL5M/SI FS = 1.04 Theta = 9.03 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

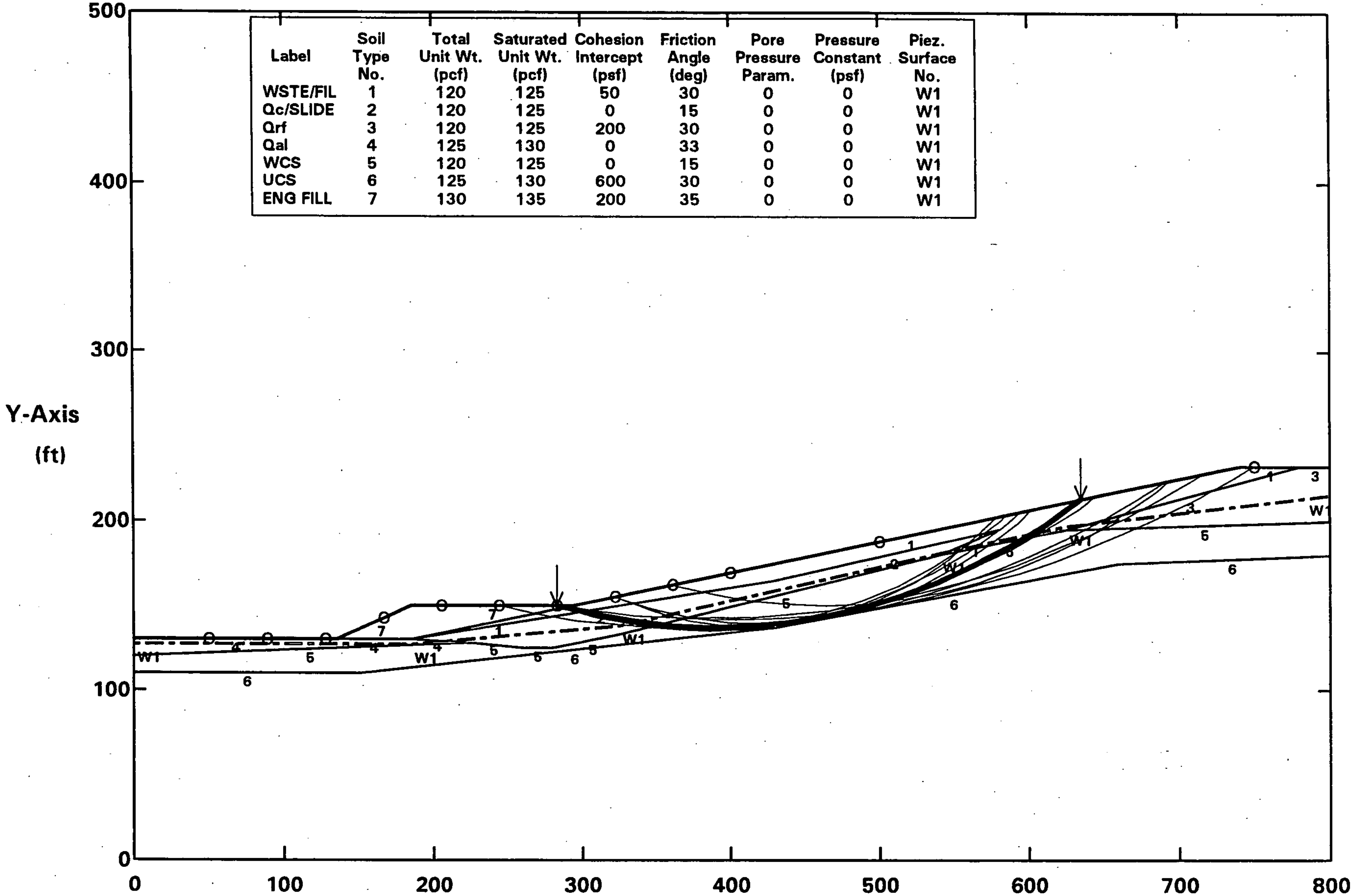
18% REGRADE WITH BUTTRESS CONDITION

ROCKY FLATS OLF - M&E D 18%W/BM - WCS = 15 deg - W/AVEGW - CIRCULAR - 0.06g
All surfaces evaluated. C:DBAC06.PLT By: STAN KLINE 10-26-04 12:23am



Factors Of Safety Calculated By The Modified Bishop Method

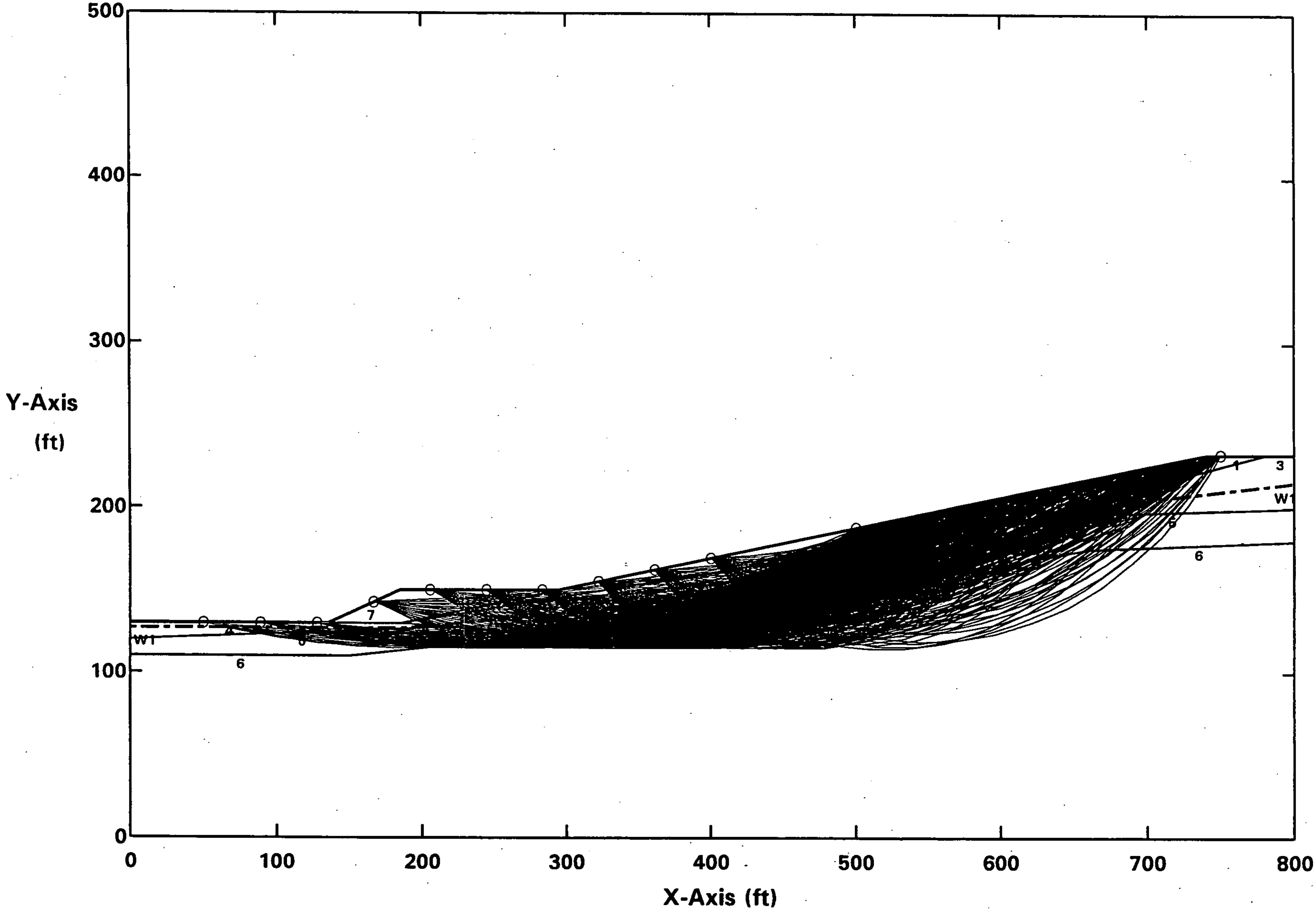
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/AVEGW - CIRCULAR - 0.06g
Ten Most Critical. C:DBAC06.PLT By: STAN KLINE 10-26-04 12:23am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FSmin=0.96 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

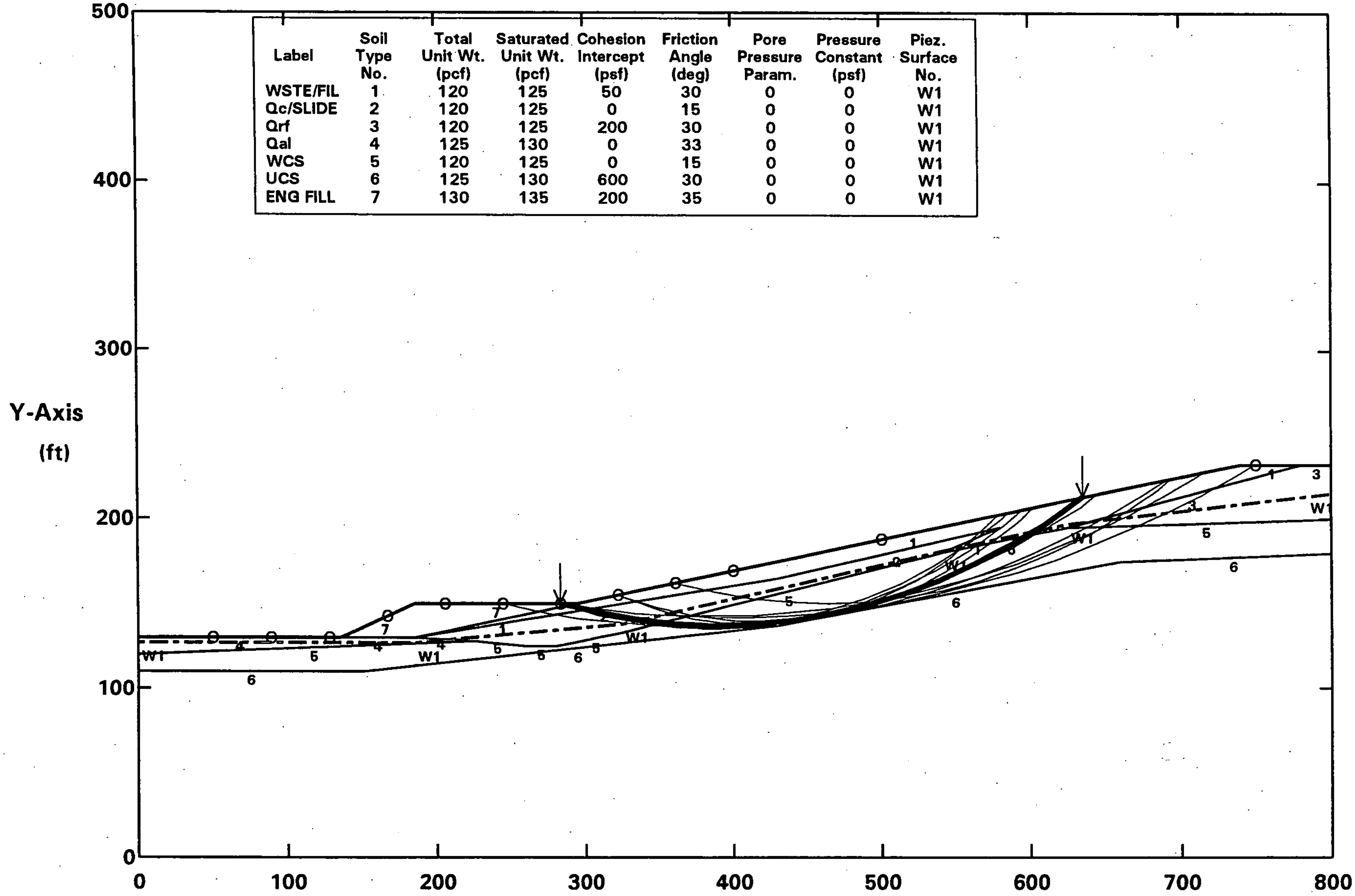
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/AVEGW - CIRCULAR - 0.05g
All surfaces evaluated. C:DBAC05.PLT By: STAN KLINE 10-26-04 12:22am



Factors Of Safety Calculated By The Modified Bishop Method

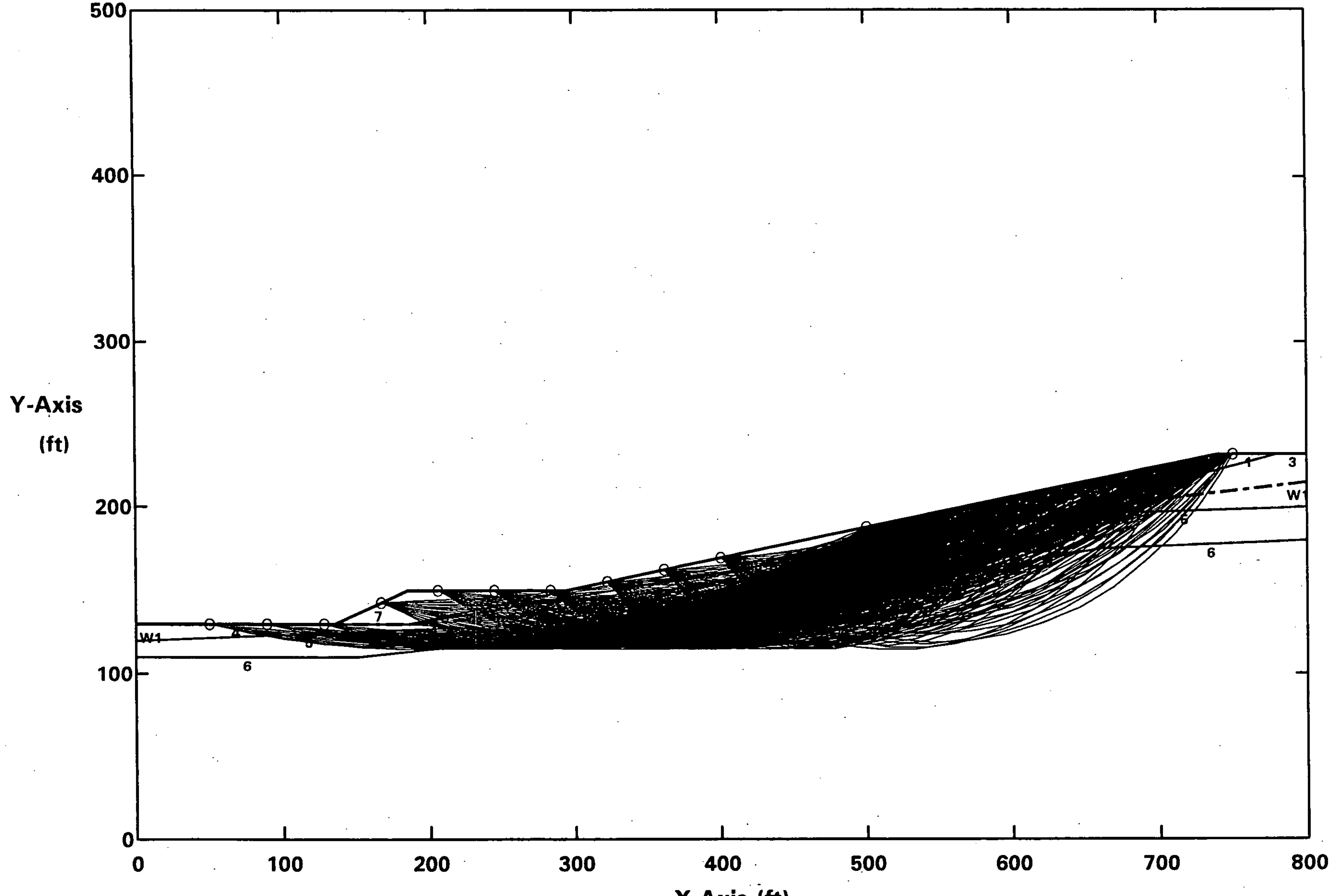
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/AVEGW - CIRCULAR - 0.05g
Ten Most Critical. C:DBAC05.PLT By: STAN KLINE 10-26-04 12:22am

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1



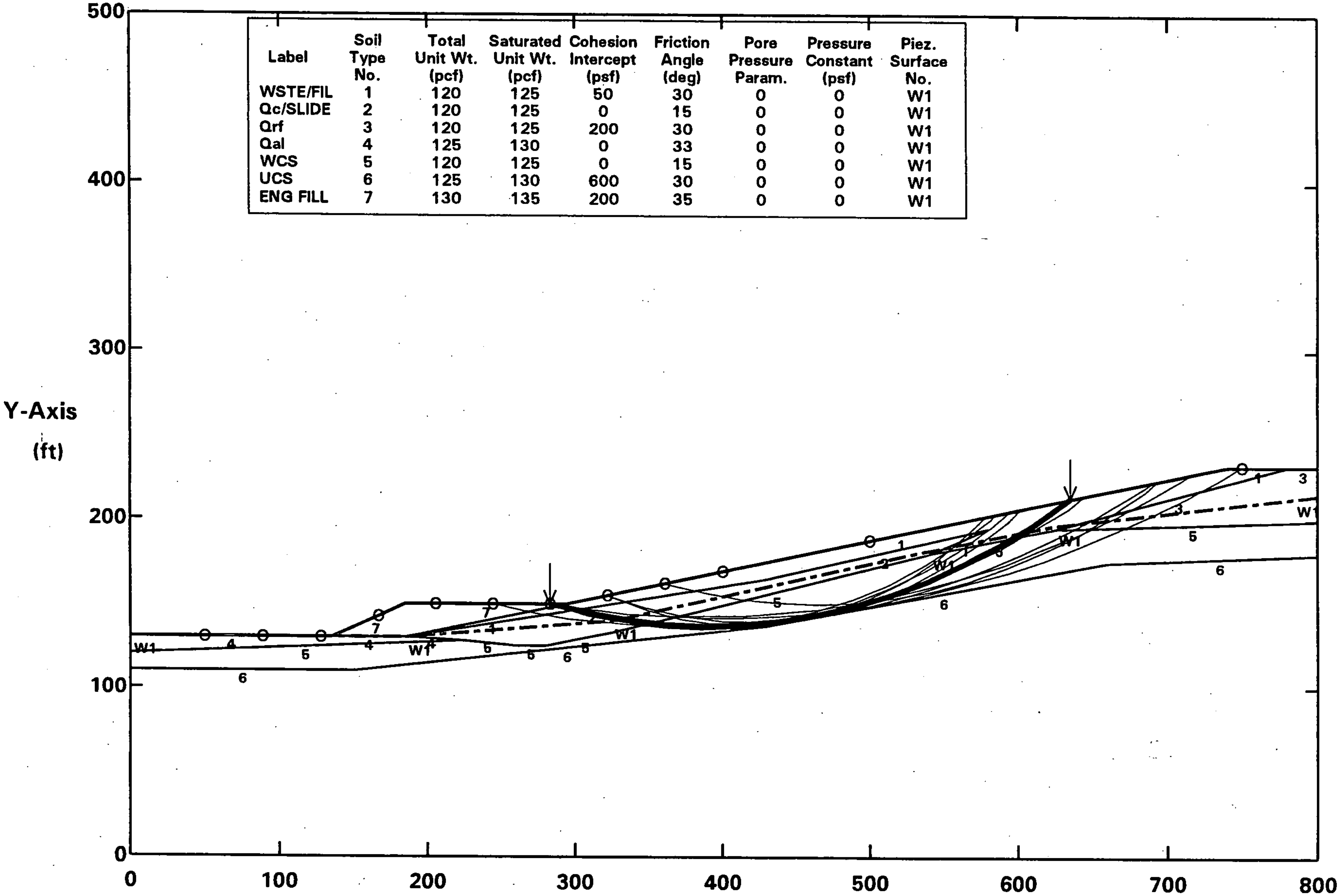
PCSTABL5M/SI FSmin=1.00 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.06g
All surfaces evaluated. C:DBHC06.PLT By: STAN KLINE 10-26-04 12:28am



Factors Of Safety Calculated By The Modified Bishop Method

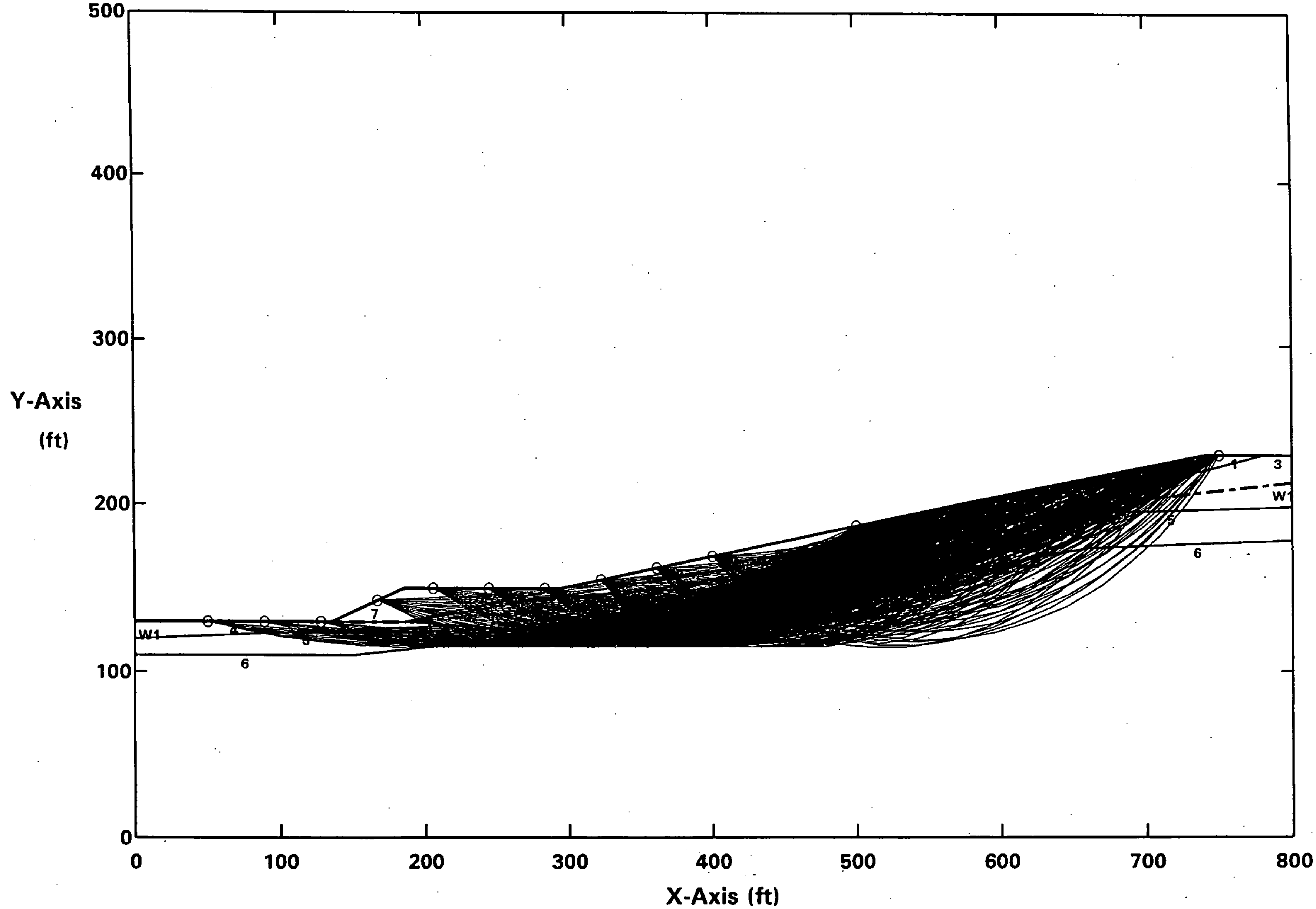
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.06g
Ten Most Critical. C:DBHC06.PLT By: STAN KLINE 10-26-04 12:28am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

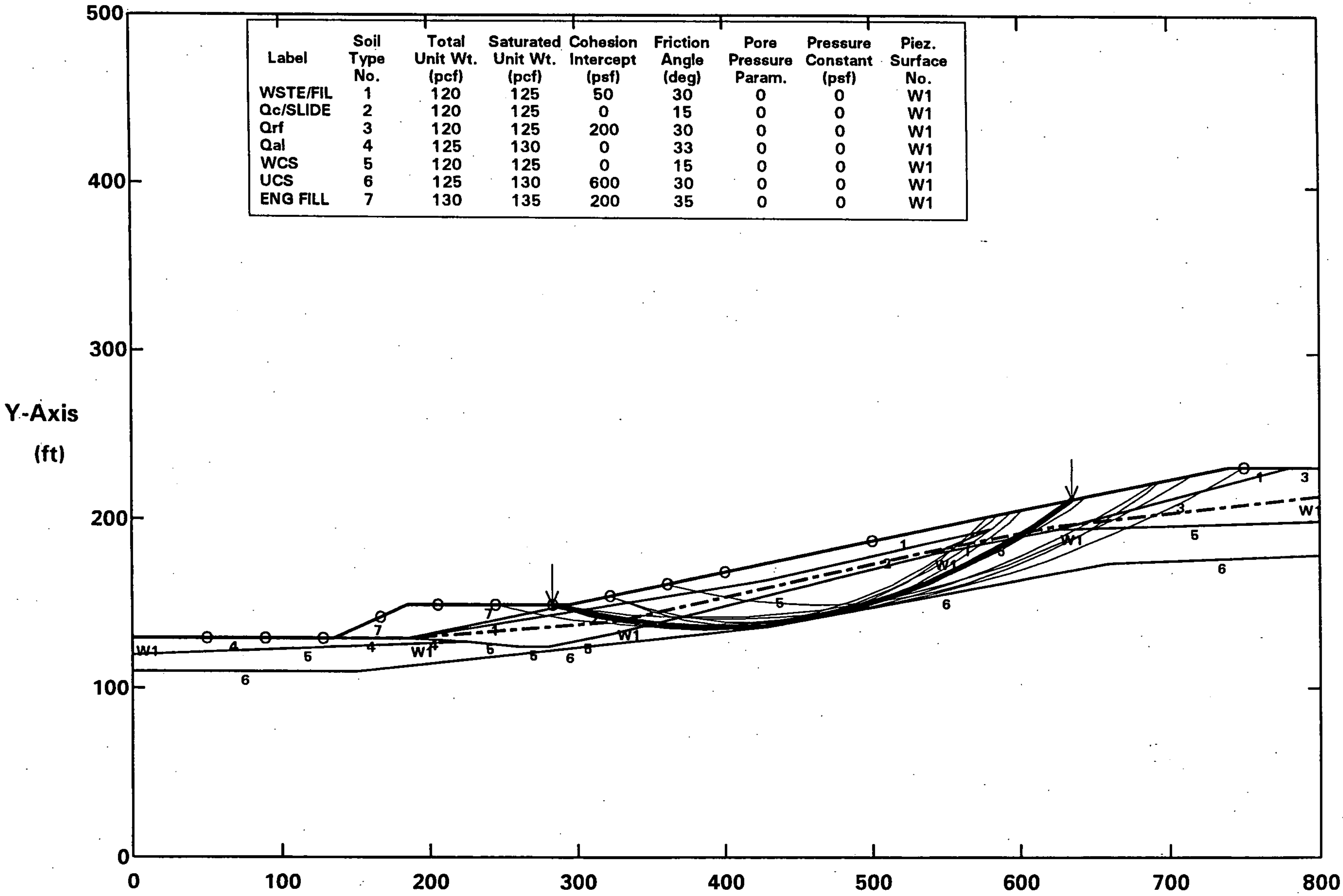
PCSTABL5M/SI FSmin=0.93 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.04g
All surfaces evaluated. C:DBHC04.PLT By: STAN KLINE 10-26-04 12:27am



Factors Of Safety Calculated By The Modified Bishop Method

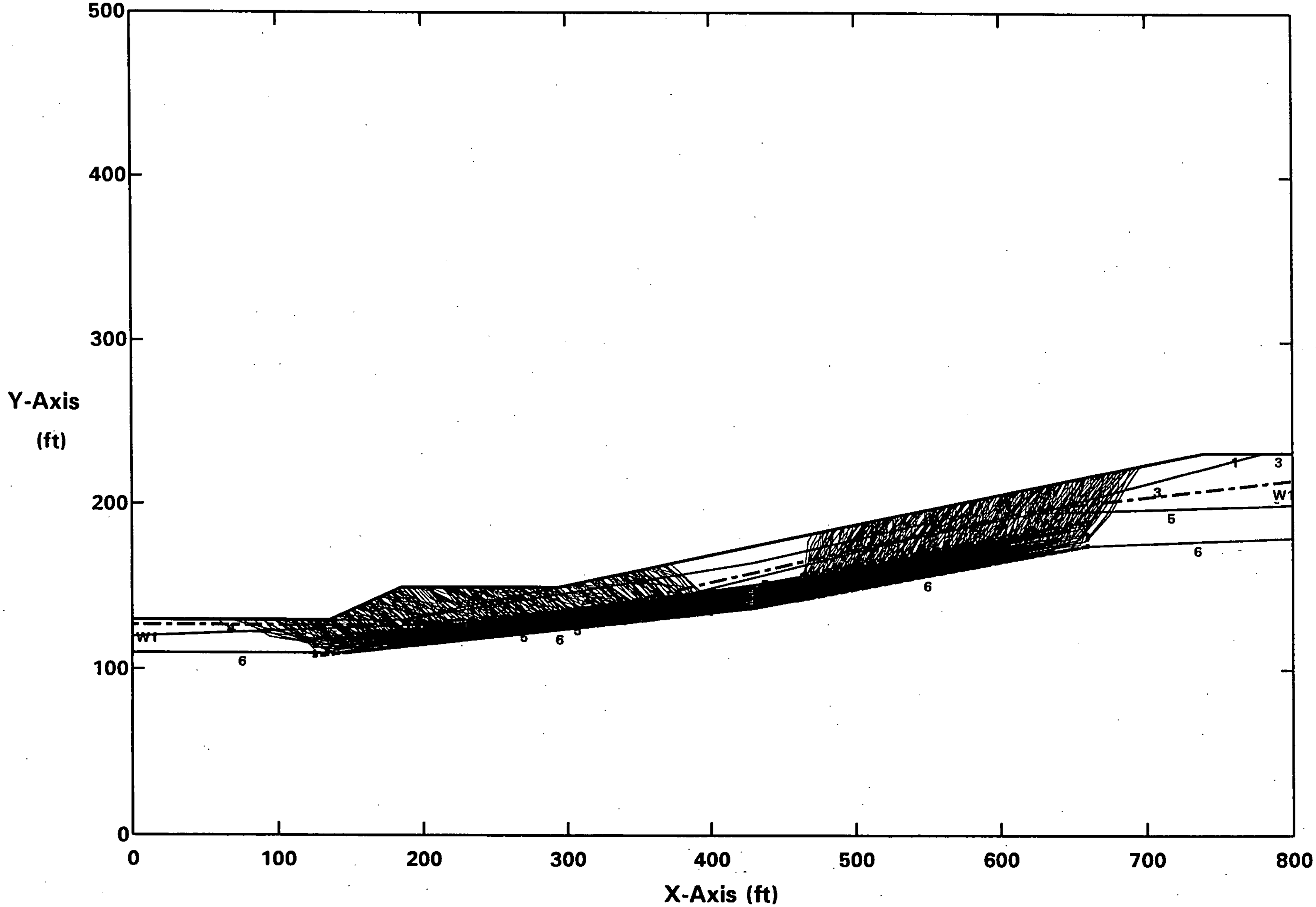
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/HIGHGW - CIRCULAR - 0.04g
Ten Most Critical. C:DBHC04.PLT By: STAN KLINE 10-26-04 12:27am



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

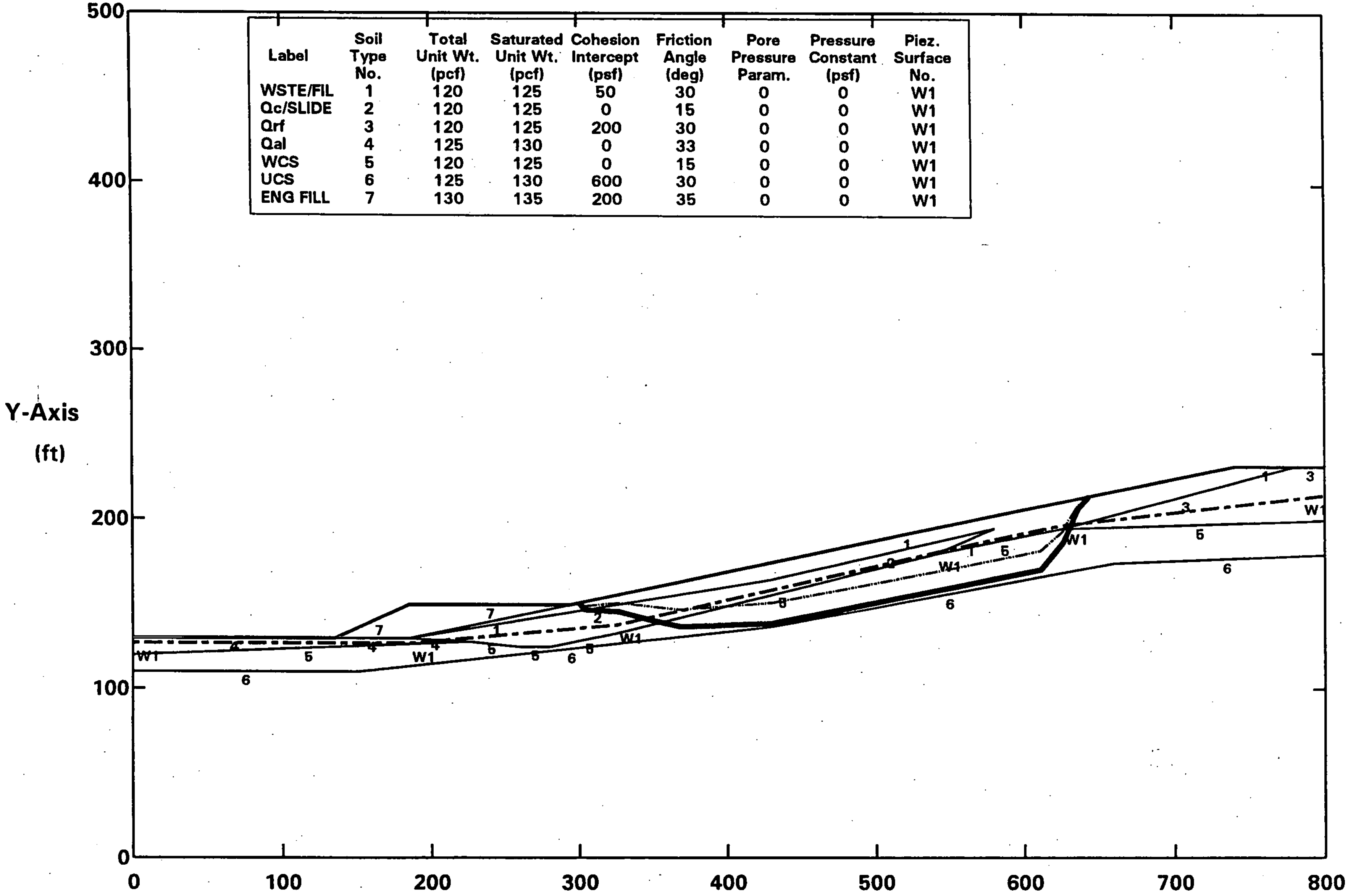
PCSTABL5M/SI FSmin=1.02 X-Axis (ft)
Factors Of Safety Calculated By The Modified Bishop Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
All surfaces evaluated. C:DBAS06.PLT By: STAN KLINE 10-24-04 8:09pm



Factors Of Safety Calculated By The Modified Janbu Method

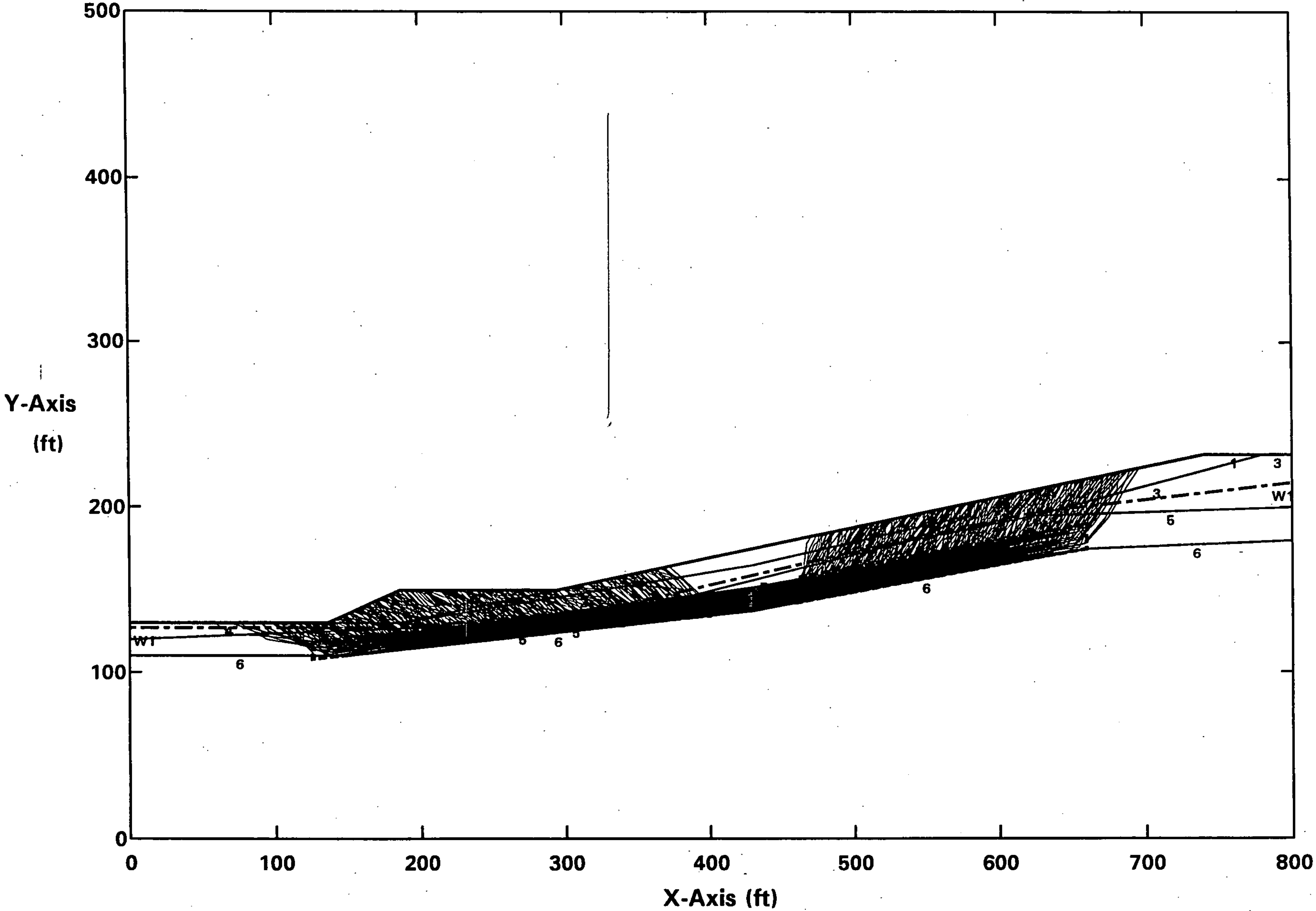
ROCKY FLATS OLF - M&E D 18%W/BM - WCS=15 deg - W/AVEGW - SLIDING BLOCK - 0.06g
Surface #1-DBAS06.OUT. C:DBAS06SP.PLT By: STAN KLINE 10-24-04 8:13pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

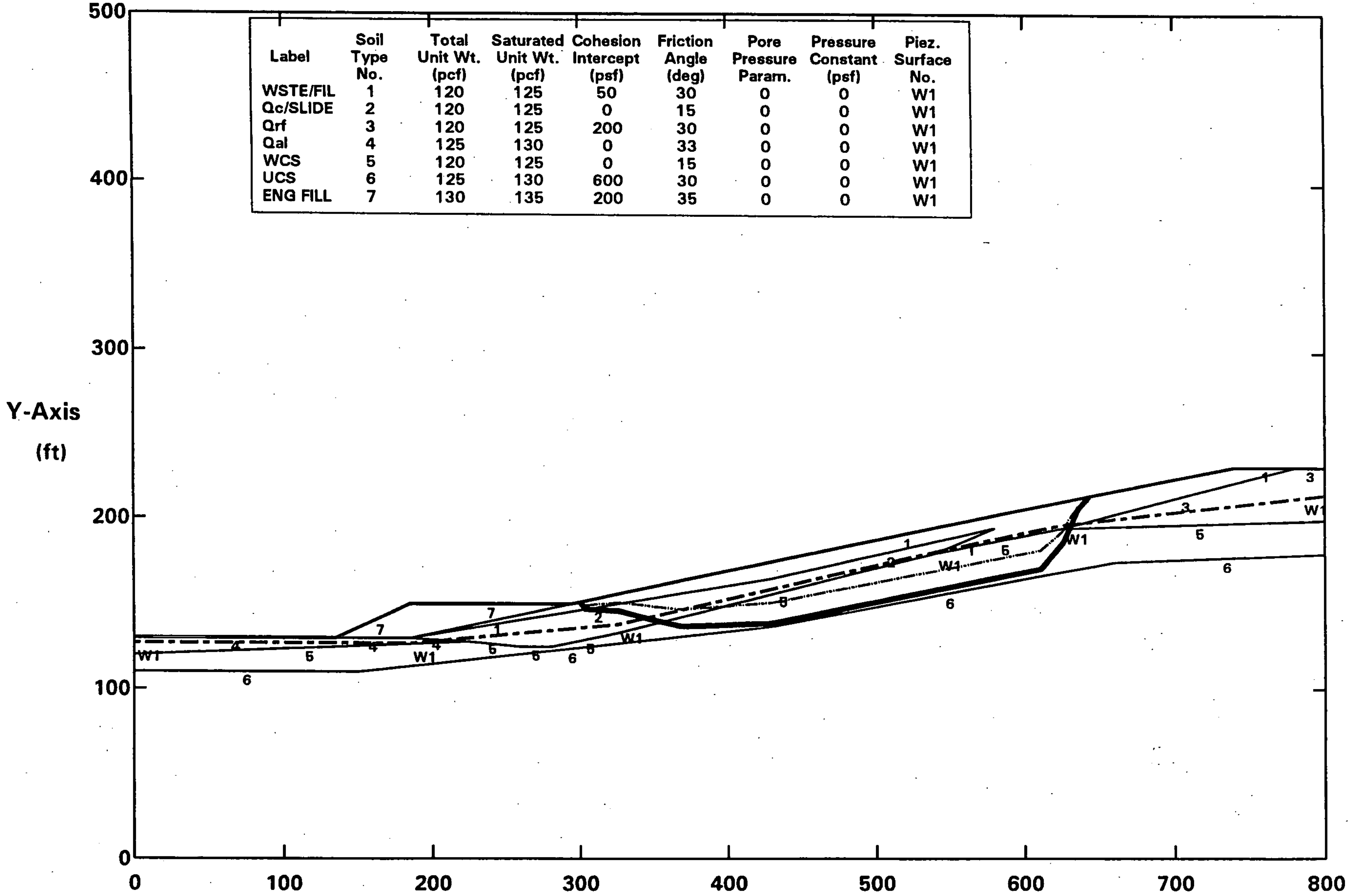
PCSTABL5M/SI FS=0.94 Theta=7.93 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

ROCKY FLATS OLF - M&E D 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.04g
All surfaces evaluated. C:DBAS04.PLT By: STAN KLINE 10-24-04 8:06pm



Factors Of Safety Calculated By The Modified Janbu Method

ROCKY FLATS OLF - M&E D 18%W/BM - WCS = 15 deg - W/AVEGW - SLIDING BLOCK - 0.04g
Surface #1-DBAS04.OUT. C:DBAS04SP.PLT By: STAN KLINE 10-24-04 8:08pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
WSTE/FIL	1	120	125	50	30	0	0	W1
Qc/SLIDE	2	120	125	0	15	0	0	W1
Qrf	3	120	125	200	30	0	0	W1
Qal	4	125	130	0	33	0	0	W1
WCS	5	120	125	0	15	0	0	W1
UCS	6	125	130	600	30	0	0	W1
ENG FILL	7	130	135	200	35	0	0	W1

PCSTABL5M/SI FS = 1.03 Theta = 8.15 X-Axis (ft)
Factors Of Safety Calculated By Spencer`s Method of Slices

SURFICIAL STABILITY

INFINITE SLOPE STABILITY - SIMPLIFIED APPROACH

Part I - COHESIVE AND FRICTIONAL SOIL SLOPES

(Ref. USACE [1970), EM 1110-2-1902)

Input Data

γ_{sat}	125	Total saturated unit weight of soil (pcf)
γ_w	62.4	Unit weight of water (62.4 pcf)
γ'	62.6	Submerged unit weight of soil (pcf)
α	10	Angle between seepage flow line and embankment slope
β	10.2	Angle of inclination of embankment slope with horizontal
b	5.6	Horizontal to vertical slope ratio [or cot(β) = H:V]
ϕ	30	Angle of internal friction of soil (degrees)
c	50	Cohesion intercept of soil (psf)
Ψ	0.06	Seismic coefficient
b'	5.2	Cotangent of "seismic-equivalent" angle of inclination of embankment slope w/ hor.
β'	10.9	Seismic-equivalent angle of inclination of embankment slope with horizontal (degrees)
		Additional Input for Cohesive Soil Case
z	5.0	Depth to potential slip surface (feet)
d_w	0.0	Depth to ground water surface parallel to slope (feet)

Output Data

FS	Computed static stability factor of safety
PSFS	Computed pseudo-static stability factor of safety, for seismic coefficient Ψ
K_y	Yield acceleration

Static or Pseudo-Static Stability and Yield Acceleration (Ref. Matasovic [1989)

FS	$= \{c/(\gamma\, z \cos^2\beta) + \tan\phi\, [1 - \gamma_w (z - d_w)/(\gamma\, z)] - \Psi \tan\beta \tan\phi\}/ (\Psi + \tan\beta)$
K_y	$= \{c/(\gamma\, z \cos^2\beta) + \tan\phi\, [1 - \gamma_w (z - d_w)/(\gamma\, z)] - \tan\beta\}/ (1 + \tan\beta * \tan\phi)$

FS =	2.07
PSFS =	1.52
K_y =	0.17

APPENDIX F

DEFORMATION ANALYSIS

APPENDIX F

ANALYSIS OF SEISMICALLY-INDUCED PERMANENT DISPLACEMENT OF LANDFILL SLOPES BY THE MAKDISI AND SEED PROCEDURE

INTRODUCTION

Background: A common procedure for estimating seismically-induced permanent displacements was developed by F. Makdisi and H.B. Seed (1978). This procedure has been extensively used to assess the seismic performance of earthfill slopes during earthquakes using the concept of accumulation of permanent slope displacements from corresponding pulses of strong earthquake loading, as initially proposed by Newmark (1965) for rigid-perfectly plastic materials, but subsequently modified by Makdisi and Seed to simulate the dynamic response of earthfill structures.

Design Philosophy: The engineering community generally recognizes that some permanent displacement or deformation of large fills may occur during major earthquake events, and that designing fills to completely prevent permanent displacements is typically impractical, if not impossible. Rational seismic design criteria consist of limiting displacements to levels which are likely to be tolerable. The use of such a deformation analysis is widely accepted for dams, embankments, landfills, in all of the highest seismicity regions of the country.

Advantages of the Method: It is a simple, yet rational approach, offering a significant improvement over conventional pseudo-static approach because it takes into account factors such as the predominant period and the effective peak horizontal acceleration of a potential sliding mass being analyzed. It also accounts for the variation in effective peak horizontal acceleration with depth and it is considered to give more accurate permanent displacement estimates than the Newmark (1965) method. Available simplified design curves were developed to calculate permanent displacement of earthfill slopes in the range of 100 to 200 feet for different earthquake magnitudes, but it is generally believed to be applicable to higher slopes. The simplified design curves were developed from more rigorous dynamic response analyses at embankments and slopes.

Criteria that had previously been used in engineering practice (namely seismic coefficient (K) and recommended pseudo-static factor of safety for conventional pseudo-static analysis were summarized in Figure F1 (from California Division of Mines and Geology, Special Publication 117, dated 1997). Computation of seismically-induced permanent displacement as originally proposed by Newmark (1965) is conceptually summarized in Figure F2 (from Hynes and Franklin of the USACE, 1984).

Assumptions: It assumes that failure occurs on a well-defined slip surface and that the material behaves near-elastically at stress levels below failure, but develops a perfectly plastic behavior above yield. It involves a number of simplifying assumptions which may lead to some somewhat conservative results. It was developed and calibrated based on the use of equivalent-linear strain-dependent dynamic soil parameters (shear modulus and damping ratio) and the dynamic finite element analysis of slopes. Development of this procedure is conceptually summarized on Figures F3 through F9, from initial research by Makdisi and Seed of University of California at Berkeley, 1978; from supplementary research by Hynes and Franklin of the USACE, 1984 for the analysis of earthfill slopes and embankment dams; and from seismic response studies for several geologic site conditions by Seed and Idriss, 1982.

Applications and Limitations: It is primarily applicable to materials such as compacted cohesive clay and dry sands and dense sands, which are expected to retain most of their static undrained cyclic strength, so that the resulting post-earthquake behavior is usually limited permanent deformation of the embankment, not catastrophic or flow failure. This excludes relatively loose cohesionless granular materials which are or can become saturated, and that might develop very large cyclic strains and a rapid buildup of excess pore water pressure during a strong earthquake shaking.

PRIMARY STEPS IN THE ASSESSMENT OF SEISMICALLY-INDUCED DISPLACEMENTS

The following three primary steps are involved in the applications of this simplified procedure (based on design charts), as follows:

Step I - Assessment of Yield Acceleration (K_y) of the Slope

Yield acceleration is defined as that average acceleration producing a horizontal inertial force on a potential sliding mass so as to produce a factor of safety of 1.0, and thus to cause it to experience permanent displacements. This value is a function of geometric conditions and undrained shear strength (reduced strength due to shaking or "cyclic strength") along the potential sliding mass and it is calculated using conventional limit equilibrium analyses.

Step II – Assessment of Maximum Acceleration of a Potential Sliding Mass

This step refers to evaluation of the maximum value (k_{max}) of the earthquake-induced average acceleration-time history [$k_{av}(t)$] of a potential sliding mass within earthfill slopes. This evaluation of a deformable earth structure, rather than a "rigid block" (shown on Figure F2), has been simplified by the use of design charts developed based on analyzed cases of dynamic response analyses of embankments subjected to earthquake-induced acceleration, for various potential sliding masses.

The procedure requires evaluation of peak crest acceleration, as well as an approximate distribution of peak acceleration versus depth (shown on Figures F3, F4 and F5), and an estimate of natural period of the slope being analyzed. Seed and coworkers evaluated the dynamic performance of earth structures based on both, simple close-form one-dimensional wave propagation models as well as comprehensive numerical modeling studies based on two-dimensional dynamic finite element analysis of embankments (Figure F6).

For the development of those simplified charts (Figures F7 and F9), Makdisi & Seed used:

- Strain-dependent dynamic soil parameters (shear modulus and damping ratio) which were calculated based on equivalent-linear techniques, and
- Calculated stresses acting on each element of the dynamic finite element model at each time step throughout the entire earthquake acceleration-time history (as shown in Figure F6). Normal and shear stresses along the boundary of a potential sliding mass were calculated at every time step, and their calculated resultant force, divided by the weight of the potential sliding mass to give the average acceleration acting on the sliding mass at that instant of time [$k_{av}(t)$].

The process was repeated for every time step to calculate the entire time history of the average acceleration. This acceleration is also called "effective peak acceleration" of the overall sliding mass.

Step III – Calculation of Seismically-Induced Permanent Displacements

Computation of accumulated permanent displacement along the direction of a potential sliding surface (for the initial development of these simplified design charts) was based on simple double-integration procedures (of average sliding mass acceleration-time history, where it exceeds the yield acceleration).

Based on the simplified design charts developed by Makdisi and Seed (based on previous detailed dynamic analysis for several earthfill slopes and earthquake loading conditions), accumulated permanent displacements were simply calculated based on the yield acceleration, the maximum value of acceleration of a potential sliding mass (or effective peak acceleration), and the magnitude of the earthquake for which the earthfill/landfill response is being evaluated.

PROCEDURE

The procedure involves the determination of:

Slope Geometry, Shear Wave Velocity and Natural Period

Calculation of maximum height of earthfill or refuse fill (H) at the section being considered. Section to be considered for seismic response analyses should be those resulting in the lowest static factor of safety. Evaluation would typically be made of the approximate value of shear wave velocity for the earthfill and/or refuse fill (V_s). For compacted earthfill materials, V_s is on the order of 1,000 feet per second (ft/s), and approximately 700 ft/s for refuse fill near surface, increasing with depth to approximately 900 ft/s at approximately 50 feet of depth. A simplified procedure for computing maximum crest acceleration and natural period for embankments was proposed by Makdisi and Seed (1977). The fundamental natural period of an embankment is approximated by 2.62 H/V_s.

For the RFETS project, the anticipated maximum height and thickness of the earthfill was approximately 45 feet, which based on an estimated shear wave velocity of the refuse soil mixture of 700 feet/second, resulted in a maximum first natural period of the earthfill/landfill of approximately 0.17 seconds.

Peak Horizontal Acceleration at the Base of the Embankment/Landfill

This step requires identification of primary seismic sources (faults, area sources) which are in the proximity of the site, and determine the Richter magnitude of the maximum event that could be generated at that source, and the distance from source to the project site, and calculate peak horizontal ground acceleration using a suitable ground motion attenuation relationship. If other site geologic conditions exist, namely near surface materials consisting of soil sediments instead or rock, the peak ground surface horizontal acceleration can be estimated based on simple correlations with peak rock acceleration developed by Seed and Idriss (1982) available for various typical soil profile types of stiff soil, soft soil, deep soil.

For the RFETS project, the anticipated peak horizontal acceleration in bedrock corresponding the an earthquake event with an acceleration exceedance probability of 2 percent in 50 years, as estimated by Risk Engineering (RE, 1994) and from the 2002 USGS database, are approximately 0.10g and 0.12g (gravity), respectively.

The corresponding RFETS peak horizontal acceleration in soil (at the ground surface, at the base of the earthfill), was estimated by RE at approximately 0.15g for the same probability of exceedance. Similarly, and based on approximate correlations between peak rock acceleration and peak horizontal ground acceleration developed for a stiff soil profile (as shown on Figure F7 per Seed and Idriss, 1982), the later would be on the order of 0.12g to 0.13g, which is consistent with the RE (1995) assessment. A site-specific response spectra may also be performed using the program "shake" in place of the above two spectral relationships.

Peak Horizontal Acceleration at the Crest

The crest acceleration is approximately determined based on the spectral acceleration of the embankment/landfill. For the first mode of vibration displacement, the spectral response acceleration is approximately the peak crest acceleration of the embankment/landfill. This response should correspond to the site geologic condition, such as stiff soils, soft soils, deep soil profile, or rock, as shown on Figure F8.

Approximate spectral accelerations are available for both mean or mean plus one standard deviation (84 percentile). Seismic spectral acceleration ratios (spectral acceleration divided by the maximum ground acceleration) were developed by Seed and Idriss, 1982; Seed, Ugas, Lysmer, 1974 and 1976).

The corresponding RFETS mean spectral acceleration ratio (corresponding to the acceleration at the top of the earthfill) corresponding to a predominant natural period of 0.17 second for stiff soil condition was estimated to be approximately 2.5 to 2.6 based on Seed et al (1974, 1982). Therefore, the maximum horizontal crest acceleration would be on the order of 0.30g to 0.39g for the design earthquake event. This estimate is generally consistent with spectral acceleration by RE (1995) for 0.2 seconds of 0.39g for soil conditions (and USGS value of 0.235g for rock conditions).

Parameters Needed for Yield Acceleration Evaluations

Cyclic shear strength of a soil differs from static undrained shear strength in that, due the transient nature of earthquake loading, where seismic loads are not only variable, but might even reverse direction within a very short instant of time. Consequently, an earthfill can be subject to a number of stress pulses equal to or higher than its static failure stress, and that simply produces some permanent deformation rather than complete failure stress. Thus, for the purpose of this analysis, the **dynamic yield strength** is defined as the maximum stress level below which the material exhibits a near-elastic behavior (when subjected to cyclic stresses of number and frequencies consistent to those induced by earthquake shaking), and above which the material exhibits permanent plastic deformation (of magnitude dependent on the number and frequency of the pulses applied).

Extensive studies on the cyclic behavior of soils by special geotechnical testing in the laboratory were conduced by Seed and Chan (1966), which indicated that for conditions of no stress reversals, such as those that commonly apply to earthfill slopes, and for different values of the initial static and cyclic stress, the total stress required to produce large deformations in 10 to 100 cycles typically ranges between 90 and 110 percent of the undrained static shear strength, as shown on Figure F6. Further, studies by Thiers and Seed (1969) indicated that undrained shear strength after cyclic loading may be expected be on the order of 90 percent of its original static shear strength as long as cyclic shear strains are less than half its static failure shear strain (also shown on Figure F6). Consequently, it may be reasonably assumed on the basis of the reported experimental data, and from the value of cyclic shear strains calculated from earthquake response analyses, that the value of cyclic yield strength for a clayey material would be between 80 to 100 percent of the static undrained strength. The later value corresponds to peak cyclic shear strain amplitudes less than one quarter of the static undrained failure strain.

Cyclic Shear Strain. From comprehensive dynamic response analyses of various earthfill dams and embankment slopes in highly seismic regions it was found that, in general, peak cyclic shear strains induced during earthquakes are expected to range from 0.1 percent for magnitude 6-1/2 earthquakes with embankment base accelerations of 0.2g (gravity) to 1 percent for magnitude 8-1/4 earthquakes with base accelerations of 0.75g (Makdisi and Seed, 1978).

In the case of the RFETS-OLF project, and considering the stiff nature of clayey materials encountered at the site, with a peak cyclic strain of less 0.1 percent, and typical static failure shear strain on the order of 3 to 5 percent, the ratio of the cyclic shear strain to the static failure strain is much less than 0.2. Consequently, reduction of the static undrained shear strength as a result of the design seismic loading is considered for all practical purposes to be insignificant. Consequently, the cyclic strength used in subsequent analyses was the same as the static undrained shear strength.

Seismic Slope Stability Analysis to Estimate Yield Acceleration. The cyclic shear strength value may be used in combination with conventional limit equilibrium analysis of slopes to compute the corresponding yield acceleration using both circular and block/wedge type potential sliding surfaces. A pseudo-static type of analysis is used to perform this calculation for several horizontal seismic coefficients. Of the several analyses conducted, the yield acceleration corresponds to the horizontal seismic coefficient resulting in a pseudo-static factor of safety of 1.0. Some interpolation is usually required.

The computed yield acceleration values for the RFETS site ranged from 0.02 to 0.04 for 18-Percent Regraded OLF site without buttress, and from 0.04 to 0.06 for 18-Percent Regraded OLF site with a buttress fill.

Ratio of Maximum Values [k_{max}] of Earthfill/Embankment Average Acceleration Time History [$k_{av}(t)$] at Various Depths [y] of a Potential Sliding Mass to Crest Acceleration [$\ddot{u}_{max}$].

Once a relationship showing variations of the maximum acceleration ration [$k_{max}/\ddot{u}_{max}$] versus depth [y] of the base of a potential sliding mass 'has been established for a range of earthfill and earthquake loading conditions (Figure F5), it would then be sufficient, for design purposes, to estimate the maximum crest acceleration (as described above and using Figure F8) in a given embankment due to a specified earthquake and use this relationship to determine the maximum average acceleration for any depth of the base of a potential sliding mass, as summarized in simplified design charts by Makdisi and Seed (1978).

This simplified procedure was developed by Makdisi and Seed (1978) based on the dynamic response of earthfill with heights ranging from 100 to 600 feet (Martin, 1965), natural periods of 0.25 to 5.2 seconds, which is very similar to the normalized response results published by Ambraseys and Sarma (1967) for embankments with natural periods ranging between 0.25 and 3.0 seconds in terms of average response for eight strong motion records. Another simplified procedure was proposed by Makdisi and Seed (1977) for computing maximum crest acceleration and natural period for embankments.

The shape of average results from dynamic finite element analyses is very similar to that computed based on "shear slice" method, with variations within 10 to 20 percent for the upper portion of the earthfill and 20 to 30 percent for the lower portion of the embankment. The upper bound of the proposed maximum value of the average acceleration ratio ($k_{max}/\ddot{u}_{max}$) versus depth (y) design curve may be used where a conservative estimate of accelerations is desired (rather than the average curve). For deep seated surfaces (earthfill/landfill founded on weak soils), y/H > 1 a value of 0.35 may be used.

For the RFETS project, assuming that potential slip surface could reach the base of the earthfill (or y/H = 1), k_{max} was found to be approximately 0.10 $\pm$ 0.02.

Earthquake-Induced Permanent Displacement Calculation

The direction of movement of the sliding mass is along the sliding surface, which is assumed to be near horizontal. This assumption is not uncommon for earthfill slopes subject to strong earthquake shaking; further, studies for other directions of the sliding surface have shown that this parameter has relatively little effect on the computed displacements. For example, it has been reported that for a sliding plane with predominantly granular materials at angles of 15 degrees from the horizontal, the computed displacements were 10 to 18 percent higher than those based on horizontal plane assumptions.

Displacements are calculated to occur every time the induced average mass acceleration exceeds the yield acceleration, by a simple numerical integration. As previously indicated, for soil types with undrained strengths not significantly affected by earthquake loading, such as in the case of the RFETS-OLF project, the yield acceleration is considered to be constant.

Simplified design charts (shown on Figure F9), which were computed by Makdisi and Seed, were used for computing earthquake-induced permanent displacement for the RFETS-OLF project, based on studies for earthfill ranging in height from 75 to 150 feet, with varying slopes, and for earthquake magnitudes of 6-1/2, 7-1/2 and 8-1/4. Because the design earthquake event recommended by RE (Risk Engineering/Geomatrix, 1995) for seismically-induced displacement analyses has a magnitude of 5.9, some extrapolation was needed, as shown on Figures F10.

Simplified Design Charts

The above-referenced study showed that ratios of yield acceleration to average acceleration of a potential sliding mass (k_y/k_{max}) at various levels between the crest and base of an earthfill slope when plotted versus computed seismically-induced permanent displacement varied similarly. Further, it was found that the computed displacements varied uniformly from a maximum value (computed from the crest average acceleration time history) to a minimum value (using the base acceleration time history), as shown on Figure F3. Therefore, maximum permanent displacements were summarized by Makdisi & Seed for these two levels.

These design curves (Figure F9) were developed for 6-1/2, 7-1/2 and 8-1/4 earthquake magnitudes and peak horizontal ground accelerations (base of the embankment) of 0.2 to 0.5g, 0.2g to 0.5g, and 0.4g to 0.75g, respectively, corresponding to earthfill slopes ranging in height from 75 to 150 feet, and having fundamental natural periods ranging from 0.6 to 1.1 seconds, 0.75 to 1.2 seconds and 0.8 to 1.5 seconds, respectively.

These simplified design charts have a range of yield acceleration ratios ky/kmax from approximately 0.05 to 0.9, and computed permanent displacements of less than one inch to several tens of feet. For example:

- For magnitude 6-1/2 earthquakes it was found that for relatively low values of yield acceleration, $k_y/k_{max} = 0.2$ for example, the range of computed permanent displacements using these simplified design charts would be on the order of 4 to 28 inches, while for higher values, such as $k_y/k_{max} = 0.5$, displacements were less than 5 inches. It should be noted that for values of $k_y/k_{max} < 0.1$, the basic assumptions of the method, namely the equivalent linear behavior and the small strain theory, become invalid. Similarly,

- For magnitude 7-1/2 earthquakes, it was found that for values of $k_y/k_{max} = 0.2$ and 0.5, the range of computed permanent displacements would be on the order of 12 to nearly 80 inches and less than 25 inches, respectively, and

- For magnitude 8-1/4 earthquakes, it was found that for values of $k_y/k_{max} = 0.2$ and 0.5, the range of computed permanent displacements would be on the order of 6 to nearly 23 feet and less than 3.5 feet, respectively.

Consequently, for the RFETS-OLF project, seismically-induced permanent displacements adjusted for magnitude M-5.9, as shown on Figure F10, are estimated to range from approximately 5 to 10 inches for the 18 percent regraded slope without buttress, and approximately 3 to 5 inches for the 18 percent regraded slope with buttress.

In general, a high static factor of safety will typically result in a relatively low permanent displacement. As the static factor of safety decreases, the calculated seismically-induced permanent displacements increase. Therefore, the static factor of safety, calculated using effective stress parameters, should be checked before performing a seismic response analysis to a get a "feel" for the overall seismic stability of the slope being analyzed.

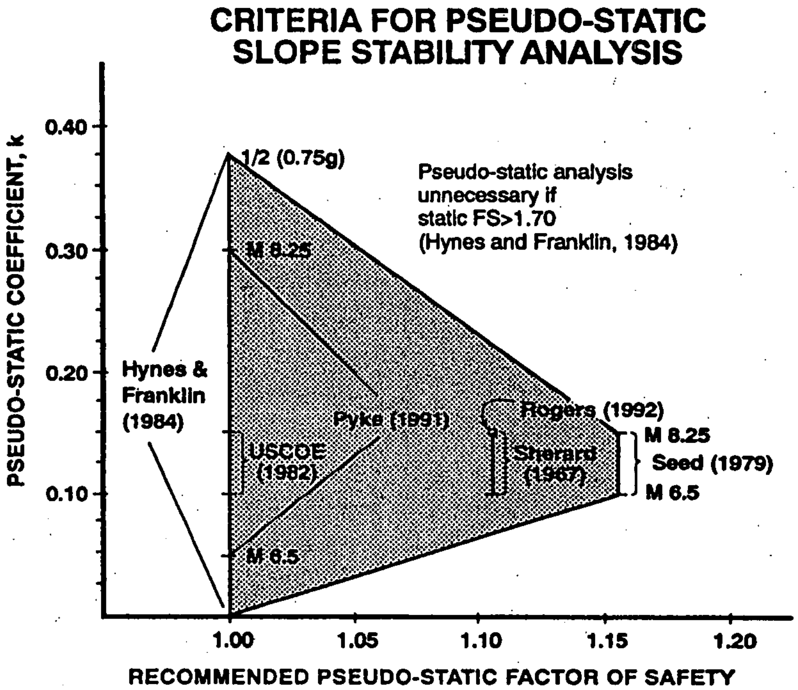


Figure 1. Approximate range of pseudo-static seismic coefficient "k" for anticipated factor of safety as proposed in the literature (references on the diagram).

Figure F1

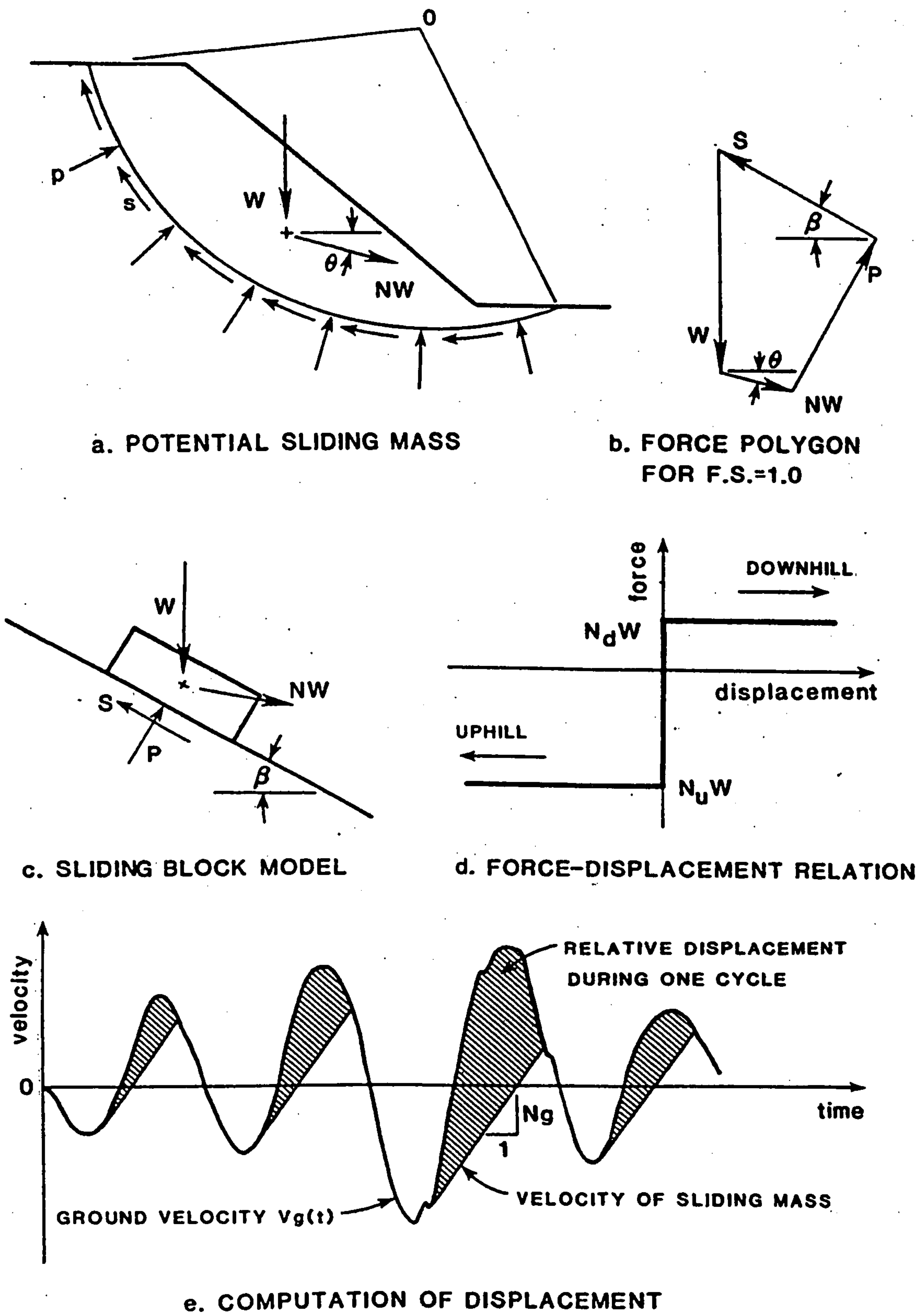


Figure 5. Elements of the sliding block analysis

Figure F2

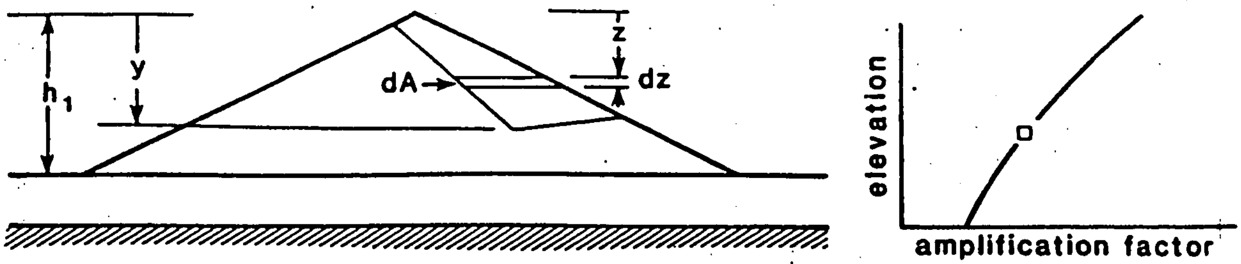


Figure 9. Computation of average acceleration acting on the sliding mass

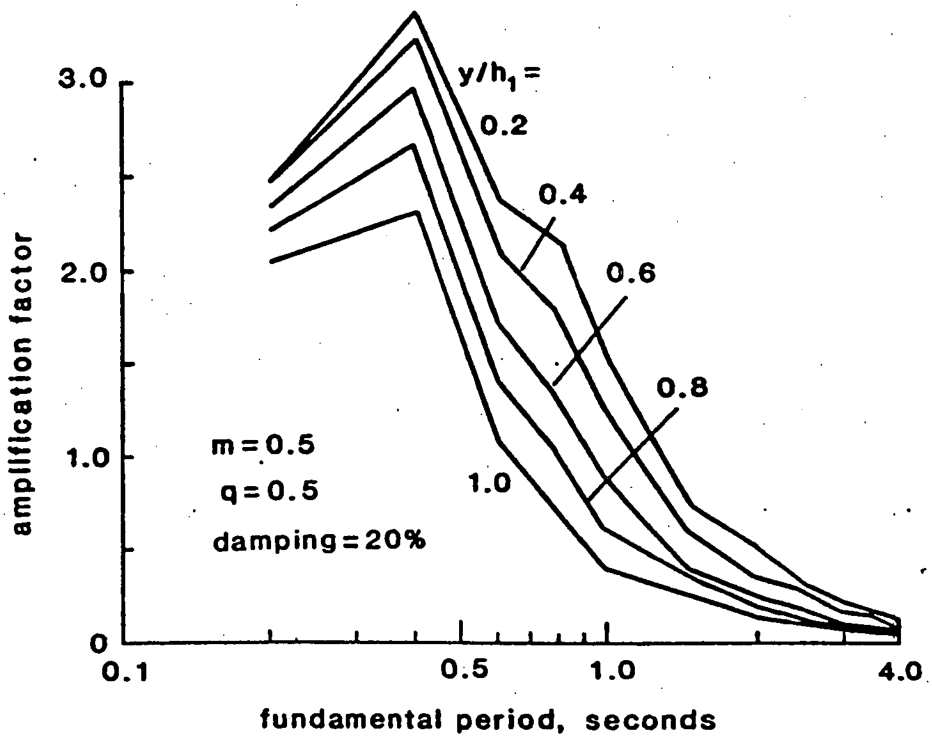


Figure 10. Amplification curves for the S 25 W component, Temblor No. 2 Record, Parkfield earthquake of 27 June 1966 (damping = 20 percent)

Figure F3

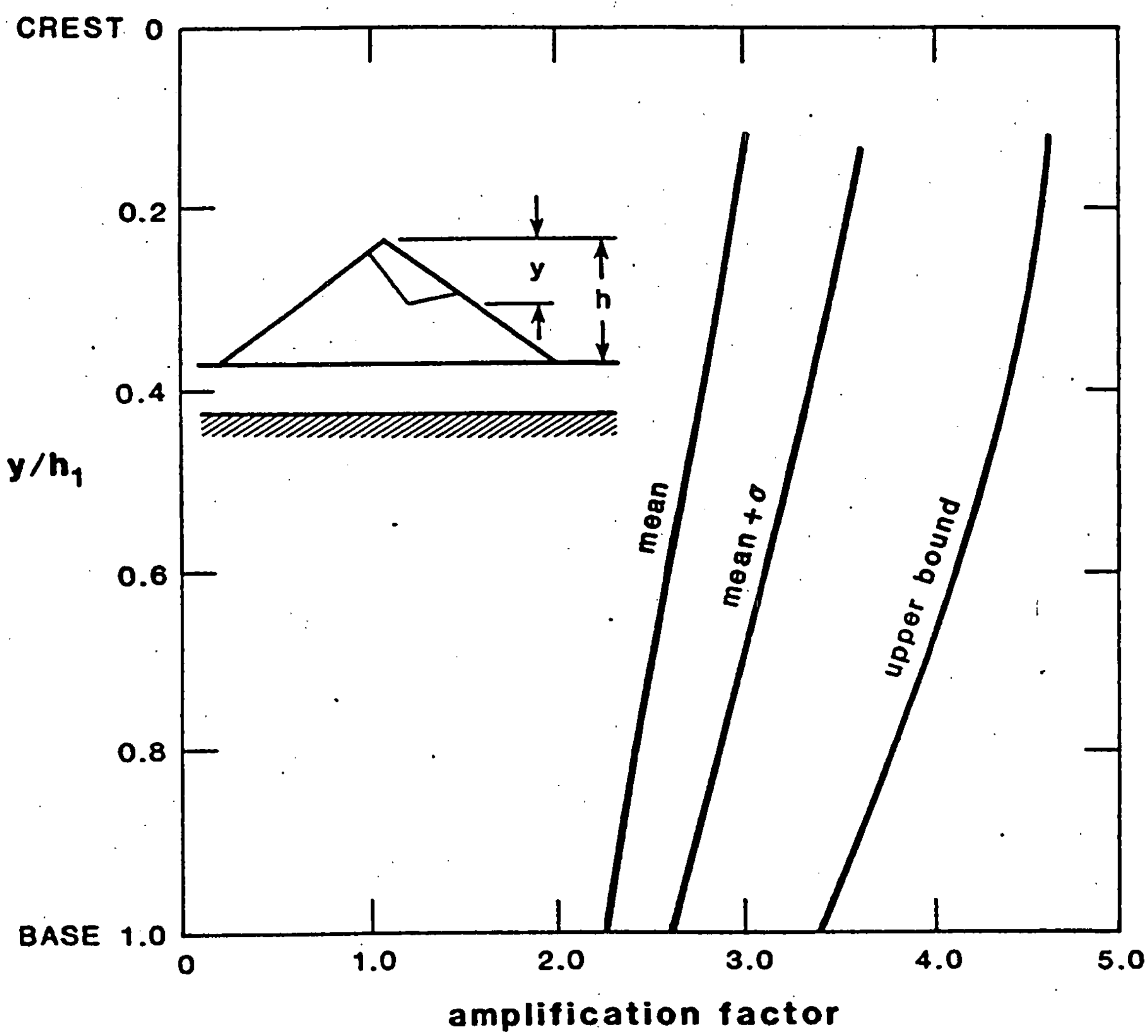


Figure 11. Amplification factors for linearly viscoelastic embankments at resonance

Figure F4

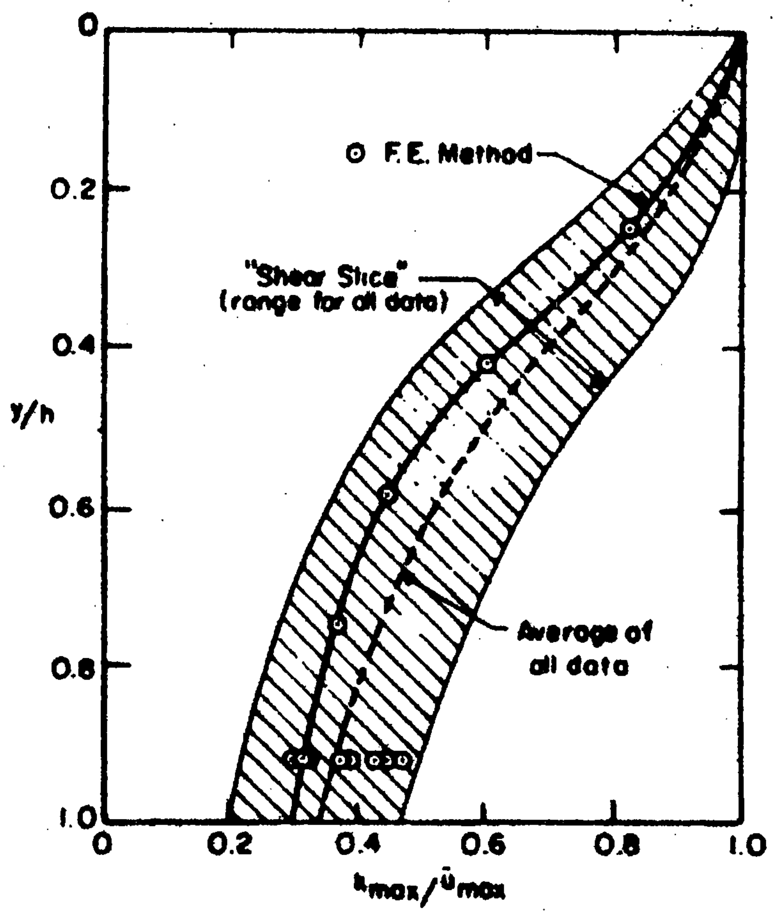


FIG. 7.—Variation of Maximum Acceleration Ratio with Depth of Sliding Mass

Figure F5

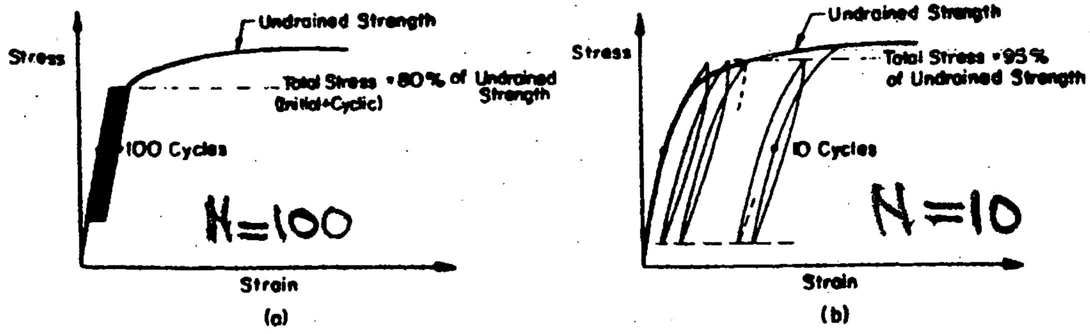


FIG. 1.—Determination of Dynamic Yield Strength

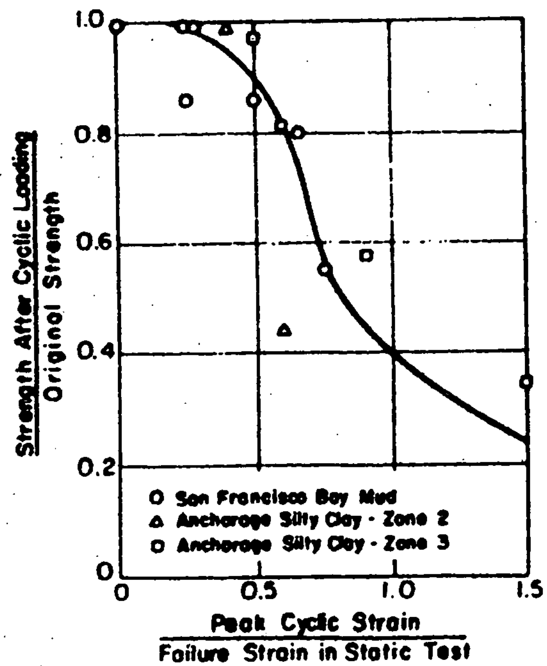
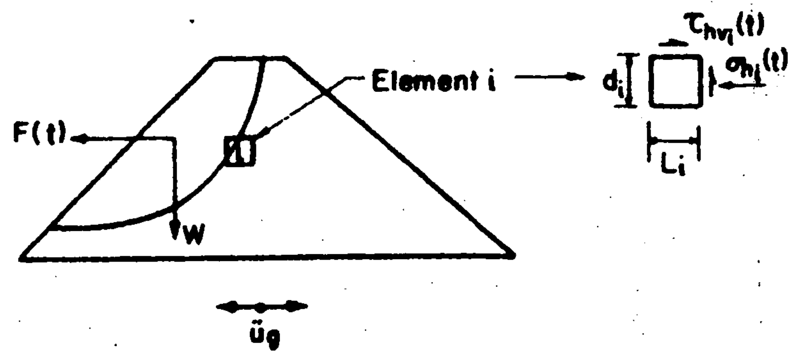


FIG. 2.—Reduction in Static Undrained Strength Due to Cyclic Loading (29)



$$F(t) = \sum_{i=1}^{n} \tau_{hv_i}(t)\, L_i + \sigma_{h_i}(t)\, d_i$$

n = number of elements along the sliding surface

$$k_{av}(t) = F(t)/W$$

FIG. 3.—Calculation of Average Acceleration from Finite Element Response Analysis

Figure F6

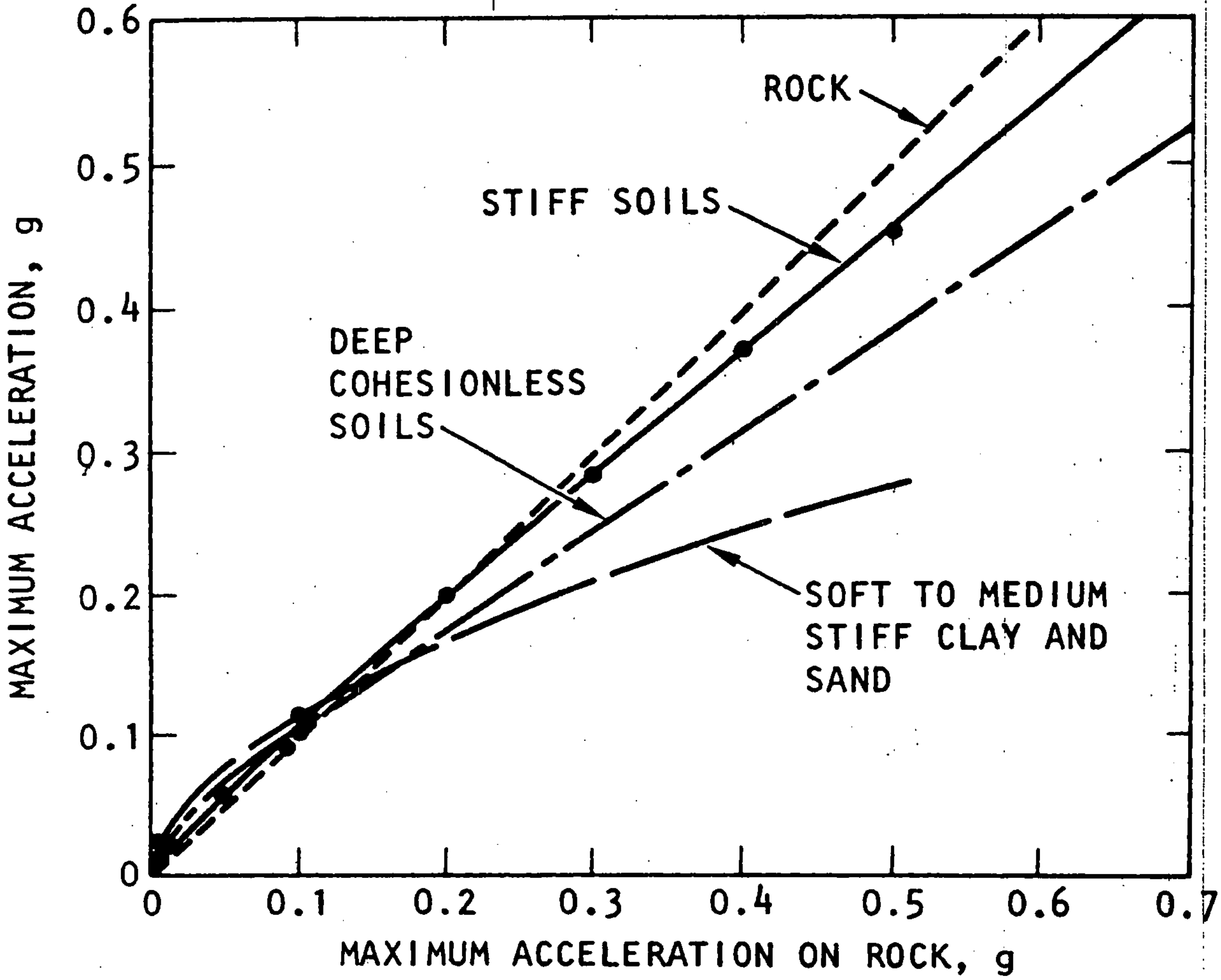


Figure 19. Approximate relationships between maximum accelerations on rock and other local site conditions.

Figure F7

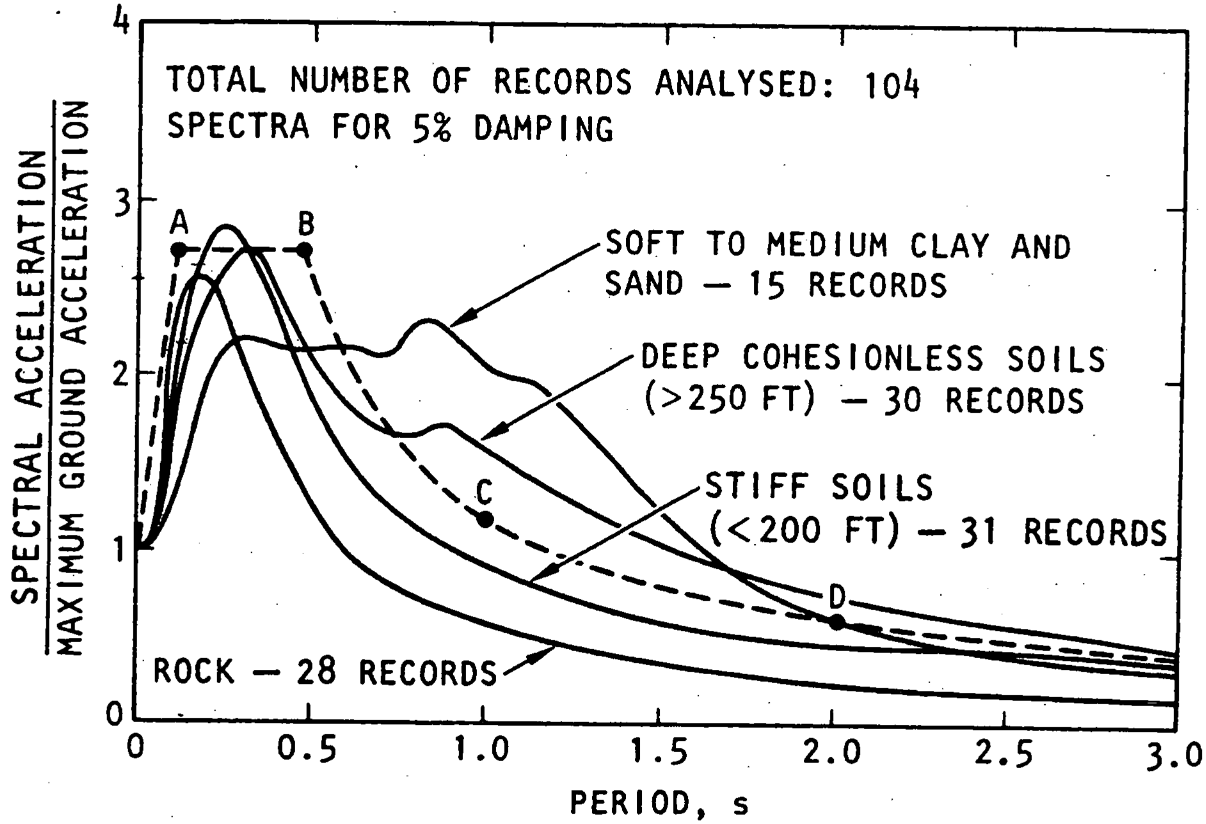
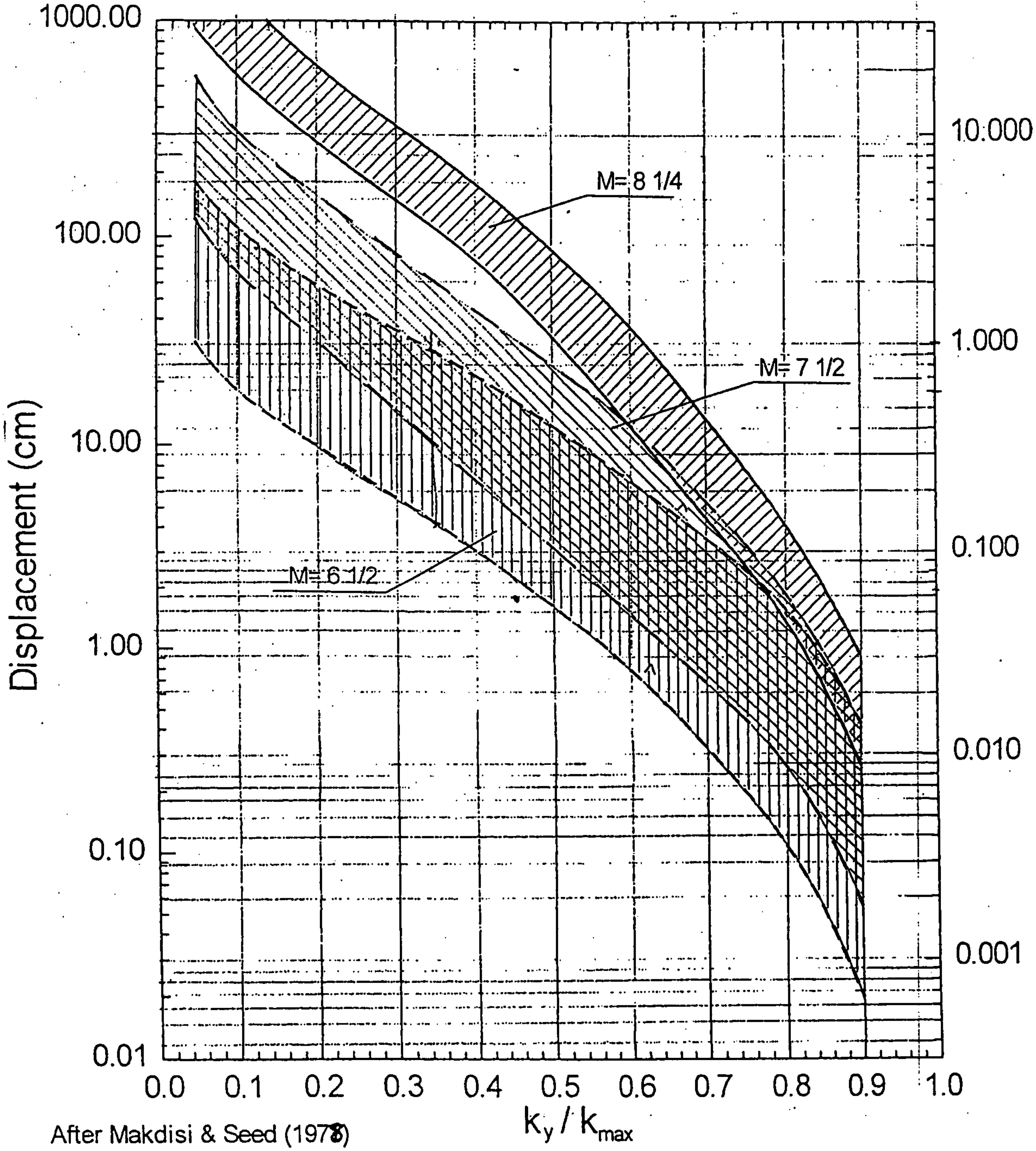


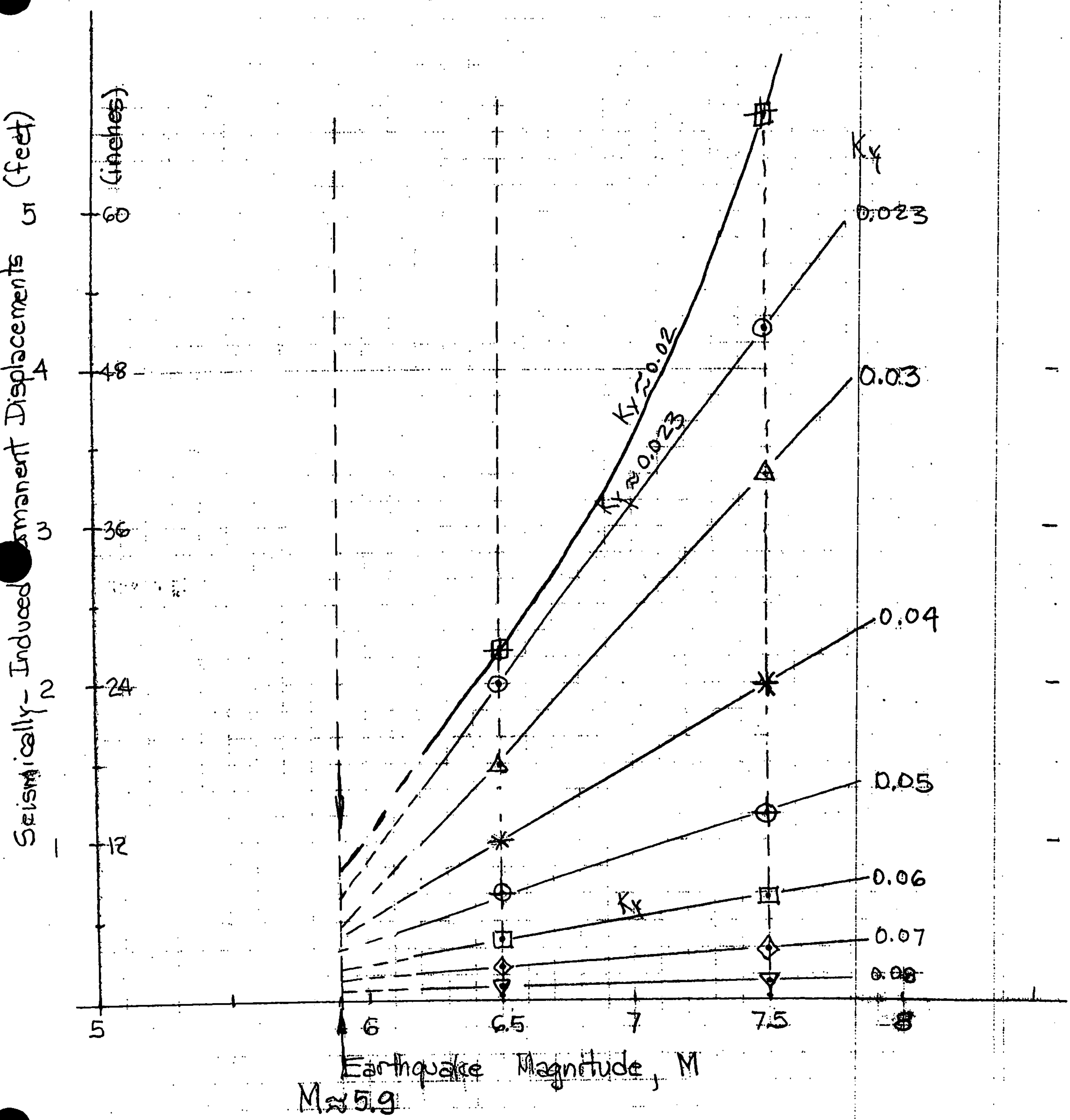
Figure 24. Average acceleration spectra for different site conditions.

Figure F8



After Makdisi & Seed (1978)

Figure F9



Seismically-Induced Permanent Displacements (feet) (inches)
5
60
4
48
3
36
2
24
1
12
Ky
0.023
0.03
0.04
0.05
0.06
0.07
0.08
Ky ≈ 0.02
Ky ≈ 0.023
Ky
5
6
6.5
7
7.5
8
Earthquake Magnitude, M
M ≈ 5.9

Figure F10